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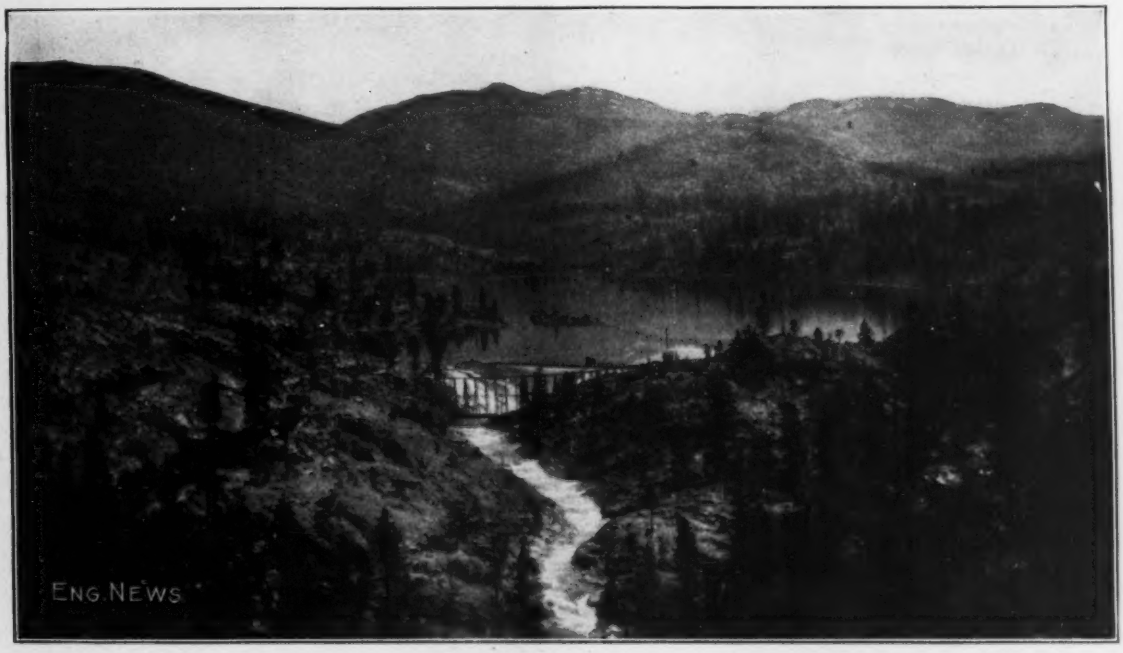
The Spaulding Dam and South Yuba Power Development of the Pacific Gas & Electric Co.

By H. C. Vensano*

Notable records, even for these days of large projects and speedy construction, have been established in the work of the Pacific Gas & Electric Co., on its South Yuba power development.



Lake Spaulding, South Yuba River, California
(June, 1912; new damsite just below foreground.)

The seven combined plants of the South Yuba and Bear Rivers, in California, will give a generating capacity of 117,500 kw. At Spaulding, there is building one of the highest and largest concrete dams in the world—to be 305 ft. high, bringing it into the class of such well known examples as the Roosevelt (204 ft.), the Shoshone (326 ft.) and the Arrowrock (351 ft.). In August of this year, 40,485 cu.yd. of concrete were mixed and poured in the dam. The best day's work (Aug. 18) was 2150 cu.yd. As this was done with four 1-yd. mixers, the writer believes it constitutes a new equipment record, surpassing the previous high figures reached in building the Medina Dam (see Engineering News, Aug. 1, 1912, p. 197).

Also it is of interest to note that during this same month there were on the job a total average of but 313 men, working 10 hours a day, including carpenters, cableway operators, and engineers, derrick men and all others, as well as those engaged in the actual handling of the concrete materials, giving an average per man per day of 4.2 cu.yd. of concrete placed.

It will be remembered that the Spaulding dam is being constructed on the head waters of the South Yuba River to store water for power and irrigation. It is the company's intention ultimately to pass the water so stored through seven power plants, of which three are now building, and afterward to use it for irrigating the fruit-raising districts of Placer County, where the Pacific Gas & Electric Co. already owns and operates an extensive system of irrigating canals. A sketch map of the proposed project is shown in Fig. 2.

The demands on this company for power in recent years have been so great as to seriously tax its capacity, with the result that the need of additional generating plants has become urgent. Therefore, when this work described was started, in May, 1912, it was deemed advisable, if in any way possible, to complete the dam and one or more of the plants by the end of the year 1913. This imposed a task of no mean proportions on the company's engineers and constructors, as the project includes, to the first power house, not only the immense Spaulding dam, but also 4456 ft. of outlet tunnel, 8.4 miles of

*Civil Engineer, Pacific Gas & Electric Co., 445 Sutter St., San Francisco, Calif.

canal, a forebay to store 425 acre-ft., 6214 ft. of steel penstock, as well as the power house and all its equipment.

Up to the present date, the work has been carried on in schedule time and within the original cost estimates; 33,330 hp. were made available from this Drum station (or Station No. 1) in November. Two additional units, generating another 33,300 hp., will be placed at a later date.

From here at the start of the work, standard- and na- row-gage lines were run to a point high above the wo for easy delivery of material and machinery. Rock wa quarried from a bluff near the south end of the wor Lumber for forms, etc., was sawed from timber on t reservoir site, much of which was heavily wooded.

The speed requirement necessitated a plant installatio at the dam of such character as would allow for th

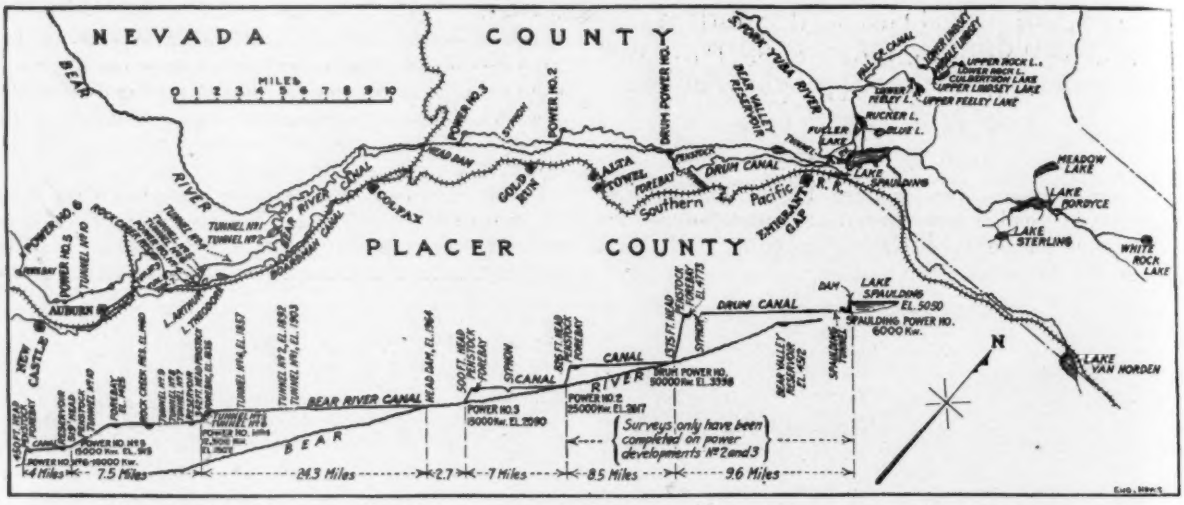


FIG. 2. MAP PLAN AND PROFILE OF SOUTH YUBA AND BEAR RIVER POWER DEVELOPMENT

SPAULDING DAM—An arched dam has been thrown across a cañon of the South Yuba River, starting with a bottom length of 60 ft. and increasing to a length (arc) of about 900 ft. at the top or 305-ft. level. The dam as it now stands (Fig. 4 shows it on Sept. 1), is at the 225-ft. level, at which point work was shut down for the season on Nov. 19. At that time 154,000 cu.yd. of concrete had been placed, the total estimated cubage for the 305-ft. level being 304,000 cu.yd. A winter layoff of

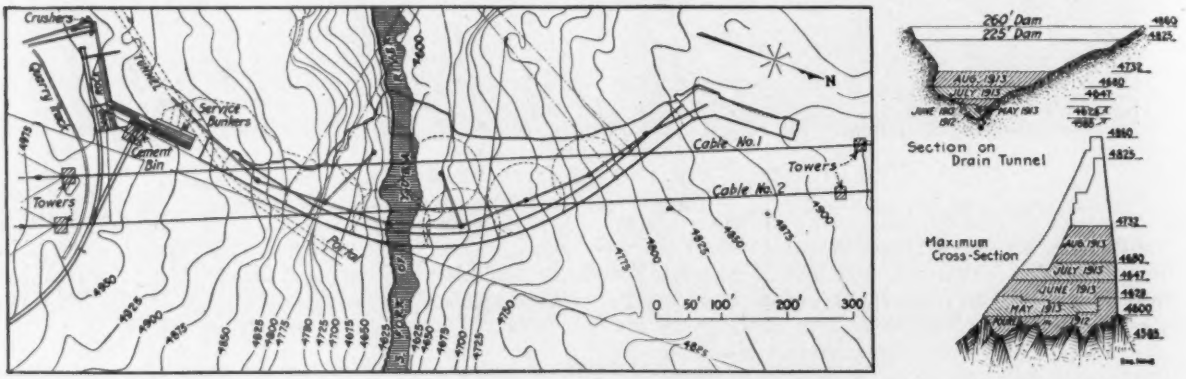


FIG. 3. PLAN AND SECTIONS OF SPAULDING DAM

several months is necessitated by the winter snows and storms of this locality. A reservoir will be created having a surface of about 805 acres and a storage capacity of some 4000 million cu.ft. The recorded annual runoff of the drainage area would fill the reservoir twice. There is a chain of some 22 regulating reservoirs discharging into this.

CONSTRUCTION PLANT—The site is some four miles from Smart, a small station on the Southern Pacific R.R.

placing of large masses of concrete daily. The plant consists of the four 1-yd. mixers above mentioned with a system of belt conveyors for loading them, and a gravity system of distributing chutes. Gravel was brought in by trains from the Colfax gravel pits, a few miles distant, and dumped into the receiving bunkers from which it was taken on belt conveyors to bins located directly over the mixers. The cement was similarly handled, i.e., from train to belt and service bins, being unsacked just before it was dumped into the service bins. From these bins, the material was dropped by gravity into measuring boxes and again into the mixers. After mixing it was, up to Oct. 15, turned out into gravity distributing chutes. Then it was necessary to use belts in place of the main chutes, as will be later described.

The chute into which the material passed from the mixer was 24 in. wide and dropped on a slope of about 4½ in. on 1 ft. This chute was of wood, lined on the bot-

tom with cast-iron plates and on the side with sheet-steel to prevent wear. Through these sheets have passed as high as 2150 yd. of concrete in one ten-hour day, so that it is readily seen that little time was lost in distributing. This single chute ramified at the lower end so as to carry the material to such points of the dam as were desired. As these chutes required little attention for operation.

FIG. 4. DOWNSTREAM FACE OF SPAULDING DAM, SHOWING CONCRETE PLANT AND GRAVITY DISTRIBUTING CHUTE

FIG. 5. DRUM CANAL, SOUTH YUBA POWER DEVELOPMENT
(Masonry outer and rubble inner wall.)

except when necessary to change their location, they gave a very economical system for the placing of the material: as it is also indicated by the small number of men on the job in proportion to the quantity placed as mentioned before.

While the conditions so far have been favorable for gravity distribution, in October the work reached a point where it was necessary to carry the mixed concrete to elevations that a gravity system cannot reach. At the end of the dam nearest the mixer plant, the work was brought to a height of about 212 ft. and at the far end to a height of 150 ft. From here up the materials had to be carried horizontally a considerable distance before they could be dropped. A system of belts has been installed for this work.

In the past, with belt systems of distribution for mixed concrete, the chief difficulty seems to have been in keeping the belt clean and free from concrete material adhering to it and caking upon it. This difficulty we believe has been successfully overcome by the use of compressed air. Just beneath the belt at the point where it passes back under the last roller and starts on its return, jets of air are forced against it under pressure through fan-shaped openings. These fan-shaped nozzles extending the width of the belt deliver air under pressure in a continuous stream against its face and practically remove all the concrete materials still adhering to it. This device is apparently entirely successful and maintains the belt in good working condition.

By such method of horizontal transportation for a proper distance the necessary gravity fall is again obtained and the material is dropped through chutes as before.

The gravity chutes were superseded on Oct. 15 by the belt conveyors and these operated successfully until work was shut down for the winter season. By this belt system concrete has been delivered at a rate of 2000 cu.yd. per day on a 24-in. belt traveling 400 ft. per min.

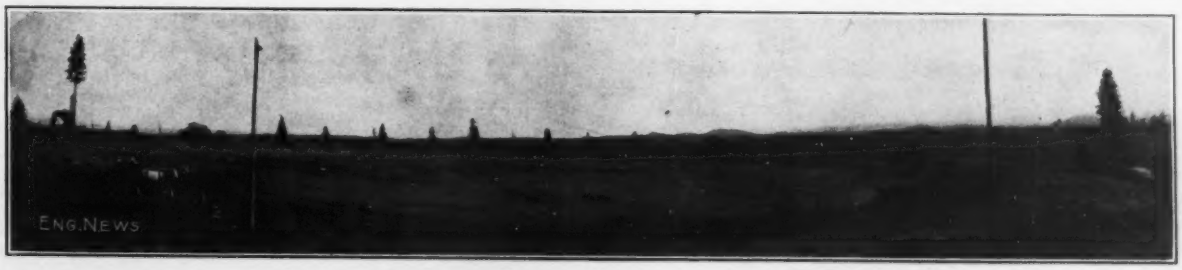


FIG. 6. DRUM FOREBAY RESERVOIR UNDER CONSTRUCTION

It is anticipated that the belt system will require but little more attention than the gravity chutes and will therefore be practically as economical of operation.

HEADWORKS, ETC.—Water will be drawn from Spaulding reservoir through two intake pressure tunnels, concrete lined, and of a finished diameter of 8 ft. 8 in. One

intake is 85 ft. above the lowest elevation of the dam and the other 185 ft. Each tunnel has a separate butterfly valve and a similar valve 1000 ft. below the dam. Eventually the intake will be controlled by a 5000-kw. generating unit installed at the adit tunnel 1100 ft. from the intake. Below here the tunnel is unlined, being 9½ ft. in diameter. After a length of 3358 ft., the water is carried a distance of 8.4 miles to the forebay, which is a large regulating reservoir dug in the top of a hill as may be seen from Fig. 6. This is 1375 ft. above the power-house site and the water is led down through a steel penstock (a second pipe is to be added when the second half of the station machinery is installed). At the forebay, the pipe is 72 in. in diameter and of ¼-in. plate; this is gradually changed until at the station the diameter is 52 in. and the plate thickness 1¼ in.

Below the dam four steam shovels dug the canal, which was completed on Nov. 20. The discharge tunnel was entirely completed on Nov. 15. In connection with the construction of the canal where it passes through rocky and precipitous country, it was deemed advisable to line about one mile of its length with rock in cement mortar. This work also has practically been completed and a section of the lined canal is shown in Fig. 5. The forebay was finished on Oct. 18; the penstock line on Nov. 24.

GENERATING STATION—The power house is on the south bank of the Bear River. To prepare a suitable site for the station, it was necessary to sluice off 40,000 cu.yd. of hill slope with a hydraulic monitor, finishing the excavation by blasting a level spot, 100x500 ft., out of bedrock. The building is of reinforced concrete and steel 77 ft. 6 in. wide, 208 ft. 8 in. long and 65 ft. high, to house four 12,500-kw. units, only two of which are to be placed immediately. The building is practically finished and the hydro-electric machinery is in place.

There are two impulse wheels, operating under 1375-ft. head at 360 r.p.m., each overhung on its generator shaft. The alternators are a revolving-field type generating at 6600 volts, 60 cycles. Between the plant switchboard and the transmission line are six 4250-kv.a. 6600/115,000-volt transformers.

There will be eventually a 109.5-mile, double-circuit, steel-tower, 115,000-volt transmission line to Cordelia (some 35 miles northeast of San Francisco), the load center of the company's system. Of the 731 steel towers required, 400 had been erected by Oct. 1, and the rest were set with one circuit strung and tested by Nov. 1.

ORGANIZATION—This development is being carried on by day labor by the company under the direction of F. G. Baum, Chief Engineer; P. M. Downing, Assistant Chief Engineer; H. C. Vensano, Civil Engineer; J. P. Jollyman, Engineer of Electrical Construction; D. H. Duncanson, Superintendent of Construction, and O. W. Peterson, Assistant Superintendent of Construction.

A Firedamp Whistle has been invented by Privy Councilor Haber and Dr. Oeiser, of Berlin, Germany, and was formally presented, on Oct. 28, to Emperor William. The principle of the device is that the tone of a whistle depends upon the density of the medium in which it is blown. The whistle is a metal cylinder, 10x2½ in. diameter, operated by an air compressor. An explosive condition in a mine is reached when the air is adulterated with about 5½% of firedamp, and demonstration to show whether this lighter-than-pure-air mixture will produce a whistle tone sufficiently different from normal to be detected by the ear is awaited with interest.

Hardwood Ties on the Panama R.R.

The use of ties of lignum-vitæ (*guayacum recina*) is a notable feature of the track construction of the Panama R.R., and the ties have given remarkably long service, those of good quality lasting for about 30 years under the tropical conditions on this road, even though unprotected by tie plates. The best quality of this timber is no longer available, however, as it is so valuable for use in connection with machinery and manufacture that it is not to be had at suitable prices for railway ties. Owing to its durability, the renewals on this 50-mile railway ranged from 4000 to 10,000 per annum (1880-1895) or 80 to 200 per mile, with an average of 7000 or 140 per mile.

The best wood is that known as black guayacum; the yellow guayacum is used also but it is of inferior quality. The present specifications, covering both species, call for first-class ties 7x9 in., 8 ft. 6 in. long, with a variation from straight edges of ½ in. on the top and bottom and 2 in. on the sides. For second-class ties the dimensions are 6½x8 in., 8 ft. 3 in. long, with variations from the straight of 1 in. and 3 in. respectively. Not more than 10% of seconds in any shipment will be accepted, and it is desired to reduce this percentage as much as possible. The specifications call for hewed ties, with not more than 1 in. of sap wood, measured across the side or face. Sawed ties will be accepted if the saw cut extends throughout the length of the tie, making parallel sides and faces.

The above particulars are taken from a report by the chief engineer (Mr. Mears) in the *Canal Record*, from which we quote as follows:

> The original track as it existed in 1885, before being disturbed by canal operations, was laid with small hardwood ties obtained on the Isthmus and from Colombia. They were of lignum vitae (guayacum recina), now spoken of as black guayacum, to distinguish it from yellow guayacum, a wood of the same family but with less power of resistance to mechanical wear or decay. Other varieties of wood, such as balsamo (or quira), and polvillo, have been used, but practically the only wood that has stood the test of time is the black guayacum.
>
> The guayacum ties procured by the old company were very small, being "pole" ties, 5 to 6 in. thick, with a 6- to 7-in. face, and 8 ft. long; some of them were quite crooked and irregular in shape. These carried the light traffic, but when traffic was increased by the canal construction work it was found necessary to replace the small ties with those of larger dimensions. The small ties were allowed to remain in the track in the section between Empire and Culebra, where the line was double-tracked, and where the traffic was comparatively light. There are many of these old ties still in use.
>
> Many of the ties removed from the main track are now being relaid on the tracks connecting with the new terminal docks at Cristobal, the timber being practically as good as ever. Their smaller size is not objectionable in the yard tracks, and it is expected that they will still have a long life. In this service tie-plates are not necessary, which results in some saving.
>
> The hardwood ties in the old track were, generally speaking, in very good condition. There were few, if any, signs of decay, but in many cases (especially with the smaller ties) they were badly worn at the rail seat by the mechanical action of the base of the rail, no tie-plates being used. They were also "spike killed," caused by replacing spikes and changing rail. These local hardwood ties are from 20 to 25 years old, and have been used in a tropical climate where all other wood decays in from three to five years.
>
> The black guayacum cross-tie is probably a thing of the past. Such material is now so valuable for other purposes in connection with machinery and manufacturing arts, that it is not to be expected that it can be procured at reasonable prices for ties. The Panama R.R. has procured only 4000 or 5000 guayacum ties in the past six years, and most of these have been of the inferior variety known as yellow guayacum.

Slag Foundation for a 305-Ft. Steel Chimney

By C. W. Cromwell*

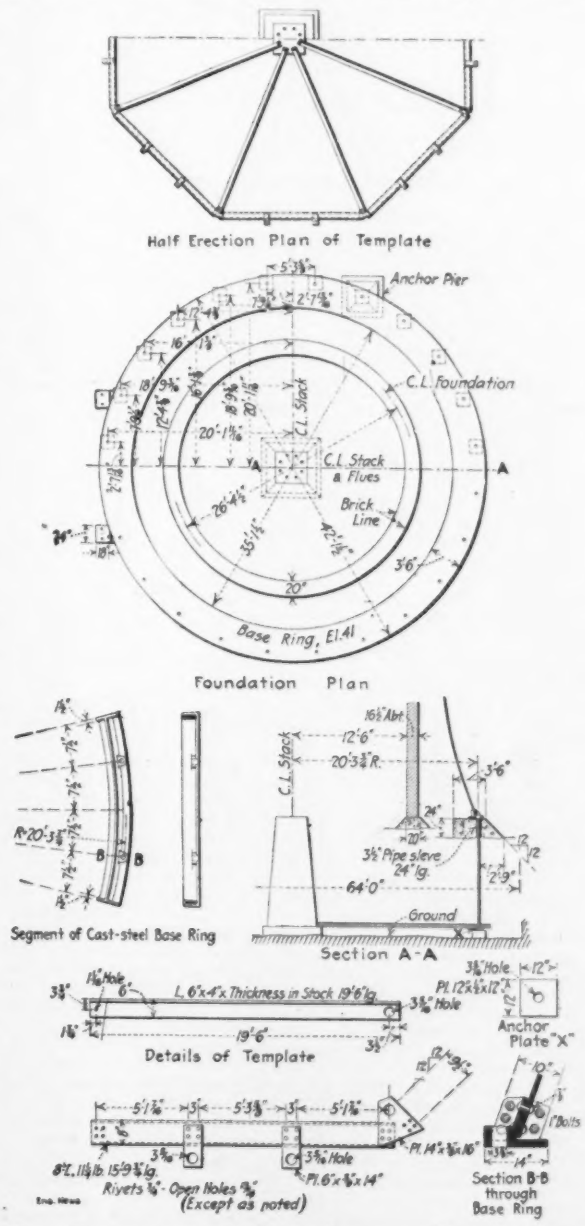
The Calumet & Arizona Mining Co. has erected a 305-ft. steel chimney, as a part of the new smelter at Douglas, Ariz., the foundation for which was made with hot slag from the blast furnaces of the old plant of the company.

The chimney is 25 ft. 9½ in. in diameter inside of the steel shell and 305 ft. from top of foundation to top of chimney. The bell is 40 ft. high and 40 ft. in diameter at base. This bell is lined with double-pressed wire-cut standard-size brick, starting vertically with a 17-in. wall, 25 ft. inside diameter, until the steel shell is reached when it is made one 4-in. layer keyed against the shell. Above the bell it is lined with 4x6x8-in. acid-proof tile supported on 4-in. leg of shelf angles spaced about 15 ft. apart. About 28,000 brick were required for lining the bell and 57,000 tile for lining the upper portion. At the top of the bell, openings were made on opopsite sides for two flues 9 ft. wide and 25 and 30 ft. high respectively. Between these flues was placed a baffle extending from a few feet below top of bell to the top of highest flue opening.

The chimney was designed for a wind load of 50 lb. per sq.ft. or 25 lb. per sq.ft. on the projected diameter, together with the actual weights of steel and brick lining. The size of plate varied from ¼ in. at top to ½ in. at bottom with horizontal rivet spacing varying from one line of ⅝-in. rivets in 3-in. centers at the top to a quadruple-riveted lap joint with ⅞-in. rivets on ¾-in. centers at the top of bell. The bell was made from 36 ½-in. plates extending to the top of bell, the contour curve having a radius of 115 ft. These plates were triple riveted to a base ring with ⅞-in. rivets. The base ring is made of cast steel, 1½ in. thick, 14-in. base, 11 in. high, and is made up of 12 segments bolted together with ⅞-in. bolts and spliced with a plate riveted on the inside of the shell. The base rings were connected to the foundation by 24 anchor bolts, 2⅝ in. in diameter upset to 3¼ in., 12 ft. 6 in. long; at the lower end a 12x½-in. square anchor plate was held by nuts above and below.

The excavation for foundation was 13 ft. deep and about 64 ft. in diameter, the bottom being sand and gravel. A center concrete pier was built to an elevation about 8 in. above the proposed top of foundation. Under each anchor bolts a concrete pier 18 in. square and 18 in. high was built. The bolts were held in position at the top by a steel template consisting of eight channel chords and eight radial angles which were bolted to the center pier. The anchor bolts were connected to the templates by ⅜-in. gusset plates, nuts being placed above and below the plate to hold the template in position vertically. At each bolt, two old rails were placed extending from the center pier over the bolt washer. To secure an accurate location of all bolts, an anchor pier was built around one bolt to 1 in. below the finished surface of foundation. By placing a gas pipe around this bolt near the top the bolt could be wedged accurately in place.

Hot blast-furnace slag was then poured around these piers and bolts up to the required top of foundation. The slag was poured from the regular slag cars in use at the plant, the track being shifted as required. The pouring was practically continuous. There were no cracks of any consequence apparent, and the bolts did not warp, in spite of the fact that no water was used for cooling. The total weight of the slag used was about 5200 tons. After this had cooled sufficiently, a trench



Slag Foundation for Steel Stack at Douglas, Ariz.

2 ft. deep was dug out around the anchor bolts and filled with reinforced concrete. This was finished 2 ft. 9 in. inside of the bolts and 9 in. outside, sloping 45° on the outside from these dimensions at the top as shown in the accompanying figure. This concrete top was poured about 1 in. low so that the base ring could be grouted to exact elevation after the segments had been bolted together.

The steel structure weighed 517,000 lb. and was fab-

*Structural Engineer, Repath & McGregor, Engineers, Douglas, Ariz.

ricated and erected by the Kansas City Structural Steel Co., of Kansas City, Mo. The chimney and base were designed by Repath & McGregor, of Douglas, Ariz.; L. W. Emerson had personal supervision of the design, and H. A. Clark was superintendent of construction.

Another steel chimney 20 ft. 7½ in. in diameter by 279 ft. high was built later by this company, in which the same kind of base was used with the same satisfactory results.

Charges for Public Water Service to Private Fire Protection Systems*

By W. E. Miller†

When the rates of a water utility which furnishes service to private fire-protection systems in its territory are under review or are in process of readjustment the question as to how much of the utility's revenue should be derived from that class of service becomes a subject for serious consideration. The question is involved in the rate case of the Milwaukee Water-Works, now pending before the Railroad Commission of Wisconsin. The arguments for and against the establishment of schedule charges for service of this kind will be summarized with particular reference to conditions in Milwaukee.

The Milwaukee Water-Works now has about 150 connections of its mains with private fire-protection systems. Many of these are for automatic sprinkler service, others serve standpipes having inside hose attachments and probably some are for service to private yard hydrants. Some of those first installed are of 6-in. diameter, but all of the more recently made connections are of the 4-in. size. The water department no longer permits branch connections larger than 4 in. in diameter to be made, but it allows two of that size to supply a 6-in. private line. All have been made at the expense of the property owners served, so that the department has no property the investment in which is chargeable wholly to this class of service. The city has heretofore been furnishing fire service through these connections free of charge, yet one of the department's rules (not enforced) provides that "all unmetered branches used for fire purposes must be controlled by a meter approved by the Board of Public Works." The rules contemplate the installation of the meter by, or at the expense of, the property owner in each instance.

After having made and submitted a tentative valuation of the physical property of the Milwaukee Water-Works, the Engineering Department of the Railroad Commission was instructed to apportion the value between public and private service. The former class included the general fire protection and municipal sewer flushing. The latter includes all other municipal as well as domestic and industrial service. The commission further called for a subdivision of the value apportioned to public service, the subdivision being between municipal hydrant service and private fire protection. The commission, therefore, sought to know the amount of the investment in the property of the utility to be supported by revenue which may hereafter be received for the furnishing of private fire protection. This involved the preparation of a report covering the following underlying and related questions:

1. What is the effect of private fire-service connections upon the necessary facilities of the utility?
2. Is private fire service fairly chargeable with the support of any part of the plant investment?
3. If question 2 be answered affirmatively, upon what basis is the amount of the investment so to be supported to be measured?

The report covered also the method of making the primary apportionment of the value of the property between public and private service. Briefly stated, that method was to apportion the value of each feature of the property on the basis of the estimated relative costs of corresponding features of hypothetical separate plants. In this connection it was shown that the reasonable maximum demand which a public-service plant should at present be capable of meeting was a rate of at least 10,000 gal. per min., or about 15,000,000 gal. per 24 hr. in the districts of greatest hazard, while that for private service should, for the present, be about 70,000 gal. per min., or 100,000,000 gal. per day, distributed over the entire city. The result of the application of the method [showed that of the total cost of the works 30.5% was the portion devoted to public and 69.5% to private or commercial service.]

Returning again to question 1 above, let us consider what is the effect of private fire-service connections upon the necessary facilities of the utility. It has been urged that such connections endanger the general fire service of the community through the possibility or even probability of wrecking and breaking of private pipe lines during fires, in which case the utility finds it impossible to keep up the necessary pressure at surrounding hydrants. Cases of the kind are reported to have occurred in other cities, though none as yet in Milwaukee. In Milwaukee the valves are adjacent to the water main in the street where they are in but little danger of becoming inaccessible during fires.

Another very important reason why the general fire-protection service in Milwaukee is not endangered by the possibility of broken piping of private fire lines lies in the fact that the water-works does not attempt, at any fire, to maintain any considerable pressure at neighboring hydrants and furnish hose streams directly therefrom. All fire streams from the city mains are supplied by steam fire engines.

It seems that we are compelled to regard connections between the city mains and private fire systems in Milwaukee as a means of making quicker and more efficient use of the water service which would otherwise be supplied only through hydrants and steam fire engines rather than to regard them as a possible menace to the general service. The writer finds no basis for considering that such connections create any greater demand upon the utility in this case than would exist without them. The facilities of the utility which are necessary to meet the requirements of the general fire service are, therefore, apparently unaffected by private fire service. If this be true it would seem that the apportionment to this class of service of a part of the investment in the property of the utility can be made only on an arbitrary basis.

COST OF FURNISHING THE SERVICE

A careful reading of the several decisions of the Railroad Commission of Wisconsin in public-utility rate cases leads strongly to the idea that the schedules of charges prescribed therein are based almost entirely upon the ascertained cost of furnishing the service, rather than upon its value to parties served. The commission has repeatedly stated that every utility is entitled to earn its legitimate operating expenses, including depreciation and taxes, and also a fair and reasonable rate of return upon the value of its property. Insofar as either the legitimate operating expenses or fixed charges of any utility are definite amounts at any period of its history or development, it would appear that when a third general class of service enters into consideration and is made to bear a share of the general expenses by apportioning them upon either a logical or arbitrary basis, the other two classes are to be relieved of the amounts so charged to the third class and benefited by a reduction of rates somewhat below what they would otherwise be. Insofar as the gross amount to be earned by a utility is definite, it is not easy to see that the utility itself is necessarily to be much concerned whether the earnings are to come from two classes or three. The consumers in the three classes appear to have far more concern in the matter.

If it be granted that the recipients of water service for private fire protection are not to be required to contribute to the fixed charges of the plant owing to an absence of any but an arbitrary basis of division thereof, we arrive at the subject of the operating expenses. It is often argued that private fire-protection systems are installed for the sole purpose of reducing cost of insurance and, therefore, of economizing in annual expenses of the property owner. This saving is effected, however, by the making of a considerable investment, which means increased charges for interest and depreciation, thereby offsetting some of the apparent saving. The granting, by fire-insurance companies, of large reductions in premiums is an unquestionable testimonial of the greater efficiency of private over public fire protection. Greater efficiency in this case does not mean that the same work or the same quantity of water accomplishes greater results, for there is only one result to be accomplished, namely, to quench the fire. It means that less water is required to accomplish the desired result. The supplying of less water means the burning of less fuel for driving the water-works pumps and consequently the furnishing of private fire protection effects a direct, though perhaps small, saving to the utility from the cost of furnishing only public fire-protection service.

So far as pumping expense for actual fire fighting is concerned it does not appear reasonable to assess any part thereof to a class of service which is a distinct advantage to the utility in reducing its expenses. But experience has

*Abstract of a paper read before the American Water Works Association, June, 1913.

†Of the Engineering Department, Wisconsin Railroad Commission, Madison, Wis.

shown that unless metered the service is likely to be misused and abused in many cases.

In the light of experience, unmetered public-water service to private fire-protection systems must be regarded as distinctly involving a special expense to the utility. The expense may be either in the cost of pumping water which is afterward stolen from the system by dishonest citizens or it may be in the cost of maintaining an adequate system of inspections and tests to detect and stop such abuses.

Metered service of the same class is apparently free from both elements of cost. The consumers' meter, controlled by the water department, becomes the department's inspector, working continuously without pay, and presumably determines, within narrow limits of accuracy, the amount of water used. The revenue due the utility therefor can readily be computed and collected, at no greater expense in general than in billing and collecting from any other consumer.

Under the existing circumstances [at Milwaukee] there does not appear to be any considerable necessity for the water utility to maintain inspections of private systems beyond that of meter reading. There is, therefore, apparently but little, if any, necessary expense to the water department on this account which is chargeable to the furnishing of private fire protection.

So far as actual cost of furnishing the service is concerned it does not appear that any charges can properly be made by the utility in such cases.

VALUE OF SERVICE

That the service furnished by a public water-works through connections to private fire lines is distinctly of value to the party served has never, so far as the writer knows, been denied. It is upon the basis of the value of the service that the strongest claim for revenue is made by the managements of water plants. This basis of charges has received the consideration of and has been used to a limited extent by the Railroad Commission of Wisconsin, but it has apparently been given greater weight in railroad-rate cases than in those involving public utilities.

The extent of the use by the commission of this basis of charges appears to have been a mere modification, for the sake of expediency, of the charges determined on the basis of actual cost. It is apparently upon this basis alone that courts have already held, and may in future cases continue to hold, that the recipients of private fire-protection service should furnish a part of the utility's revenue by the payment of schedule rates.

The service may be of value to the party served in that it may form one of two required sources of water-supply to the premises in question. A condition precedent to the granting, by insurance companies, of the maximum reduction in insurance rates for the added security of automatic sprinkler service is that the facilities shall include two separate sources of water-supply, one of which may be the city mains. The other may be a suitable tank properly elevated to furnish adequate pressure and filled from the city mains; or it may be a private pumping plant drawing its water from a stream, lake, reservoir or an adequate well. The city water service, however, apparently is not recognized as one acceptable source of supply for automatic sprinkler systems unless the minimum pressure regularly maintained in the mains of that vicinity is suitable for effective operation of the highest line of sprinklers in the building. It will, therefore, be evident that the value of city-water service for private fire protection, from the standard of a property owner, will depend upon the height of his building and the ordinary pressure in the city main in his vicinity.

There are some instances where the ordinary city-water pressure in Milwaukee is inadequate for automatic-sprinkler service in the upper stories of the buildings. In these cases the branch connections from the public mains are for the purpose of supplying water to private pumping plants which are arranged to either deliver the water into elevated tanks or to furnish direct pressure should the tanks be out of commission. In these cases the yearly value of the private fire service furnished by the water utility would seem to be measured, or measurable, by the interest and depreciation on the investment required to obtain an alternate supply of water for the private pumping plant. In the cases of industries along the rivers a small investment would provide an inexhaustible supply for the private fire pumps and the value of the city supply would be rendered quite small.

There are other cases in Milwaukee wherein the value to the property owner of the private fire service of the city water-works is much greater than in those contemplated above. The diversity of conditions found in different cases introduces great difficulties in the way of establishing schedule charges for private fire-protection service on the basis of its value to the property owner.

While this class of service has a greater or lesser value to the property owner, it is equally clear that it has some value to the water utility and to the public in general. The interest in private fire protection, which is universally recognized as more efficient fire protection, is mutual.

The interest of the water utility is, perhaps, primarily, in the reduction of the number of bad fires of long duration to be fought, but it is also interested in the continued prosperity of its patrons, which means the prevention of destruction, by fire, of industries and the consequent throwing out of employment of large numbers of workmen, many of whom are patrons of the utility.

The city at large is interested in the preservation and prosperity of its industries, the continued employment of its people and in the protection of property and human life. The public is interested greatly in insurance rates or cost of carrying fire insurance. Since insurance rates are so largely dependent upon the fire losses, and these are in turn dependent on the efficiency of fire-fighting equipment, the public as well as the individual property owner is financially interested in the installation of better fire-protection facilities in the establishments of large value.

The courts have said in certain cases that the interest of the water utility and the public in the installation of private fire-fighting systems is secondary and incidental and that of the property owner is primary and of such moment as to justify a charge for water service thereto. But it appears to the writer that such opinion results from an overestimate of the value, to the individual, of the water service and an underestimate of its value to the utility and to the public. The value of private fire-protection systems, especially automatic sprinkler systems, in the protection of human life can scarcely be expressed in dollars and cents.

It appears proper to mention, also, the fact, as reported, that the plan of requiring, by municipal ordinances, the protection of certain classes of property by automatic sprinkler systems has been extensively agitated. The City of Chicago already requires its theaters to be protected from fire by automatic sprinklers and is now (January, 1913) reported to be considering an ordinance extending the requirement to other classes of property. This is in the interest of public safety. The writer firmly believes that the time is soon coming when all of our leading cities will have such requirements in force.

The enactment of ordinances imposing upon property owners a duty of providing expensive private fire apparatus carries with it a moral obligation on the part of the city to furnish water to that apparatus instead of withholding it for use only through city hydrants and fire-department service. The water should be furnished inside the premises at no greater cost to the property owner therefor than if supplied from hydrants. The service from hydrants is presumably paid for by the property owner as a part of his general property taxes. He should be entitled, without extra charge, to make more efficient use of that same service.

There is one condition now existing, as the writer believes, only in Wisconsin, which is of such interest and importance in this connection as to deserve attention at this time. This arises from the passage, and the provisions, of the Wisconsin Public Utilities Law, under which the Railroad Commission is empowered to equitably divide the total expenses of a water plant between public and private service. It was found that several Wisconsin water utilities, and it is believed that many such utilities in other states, have not received a fair share of their revenues from the public in return for the hydrant service furnished. When the so called hydrant rentals are made to cover a better share of the fixed charges and operating expenses of a water plant and all of such expenses are provided for in the rates and earnings, the utility has less necessity of endeavoring to increase its earnings by charging separately for private fire protection.

In the case of the City of Beloit vs. Beloit Water, Gas & Electric Co. (7 W. R. C. R., 137), the Commission held that the city should pay an increased charge for fire protection and that the payment should cover all fire protection, including that formerly furnished by the company, at a special charge, to private hydrants in the yards of certain industrial plants.

SUMMARY

In view of all the considerations in the matter, most of which have been set forth above, the writer has reached the conclusion that the Milwaukee Water-Works should continue to furnish service to private fire systems free of special charge, provided they be metered, as required by the rules of the department. Conditions elsewhere may present difficulties, under this plan, so the author is not prepared to say that it should be universal.

Observations on Bridge Expansion

By H. A. Loser*

The question of bridge expansion has a number of doubtful points: (1) Some engineers regard expansion provision as a more or less unnecessary refinement and believe that bridges and similar structures of steel do not change in length perceptibly under varying temperature conditions. (2) While it is known that a straight bar of steel will expand or contract under temperature changes uniformly at the rate of 0.0000067 per degree F., there are no recorded observations to show that the same expansion-coefficient applies to a complex structure like a bridge, which contains joints, etc.

Three years ago the writer made a series of observations of steel railway bridges erected on various lines of the New York, New Haven & Hartford R.R., to determine the action of the expansion bearings. The bridges on which the observations were made are all relatively new, having been erected during the past ten years. In all, 45 observations were made, on as many different bridges. Of these 16 were pin-connected trusses, varying in length from 182 to 217 ft.; 11 were riveted through trusses, 70 to 145 ft. in span; and 18 were deck plate-girder bridges, 70 to 111½ ft. in span. The winter temperatures during which observations were made (1910-11) ranged from +15 to +56° F., and the summer temperatures (the following summer) ranged from 45° to 86° F. The variation from high to low temperature during a single set of observations ranged from 18° change as a minimum to 54° change as a maximum.

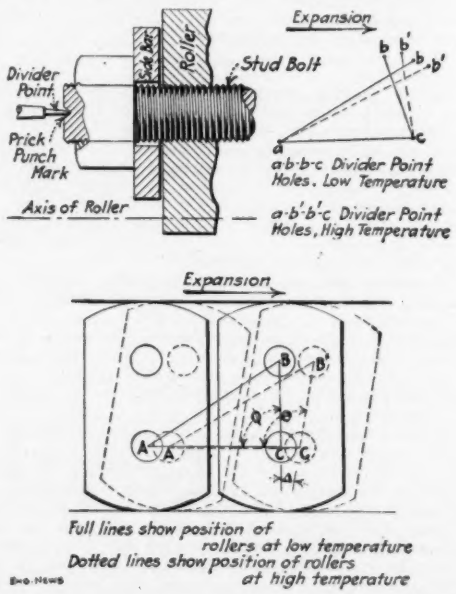
In all the through bridges observed upon, the floors were of the standard floorbeam-and-stringer construction; the deck plate-girder spans had the roadbed supported directly on the girders. The roller nests were in all cases made up of 6-in. segmental rollers connected by pairs of parallel side bars attached to the rollers with studs; the bearing surfaces of the shoes were planed.

The method of obtaining reliable measurements of the small expansion movements is illustrated by the adjoining sketch. Prick-punch marks were made in the centers of three studs in two adjacent rollers, and the distances between the marks were measured by a pair of dividers. The divider measurements were not read off on a scale, however, but were transferred directly to the pages of a notebook by pressing the divider points into the page. The second reading was recorded in this way on the same page on which the first reading (at lower or higher temperature as the case might be) had been recorded. It was an easy matter to compute or work out graphically the angular movement of the rollers as represented by the two measurements and therefrom determine the expansion or contraction as a linear measurement.

Auxiliary to the measurements on the roller observations were taken at all surfaces where sliding could occur, at both fixed and expansion ends, to see whether relative movements occurred. Match-marks made with a chisel or a prickpunch at the edge of the joint whose sliding was to be watched were carefully observed to note any change. *No sliding was observed* at either fixed or expansion end, in any of the 45 observations. Therefore, the full expansion of the bridge was in each case represented by the movement at the roller bearing.

*3000 Clifton Ave., Baltimore, Md.

To compute the coefficient of expansion, it was necessary to know the temperature of the bridge at each observation. It might be thought that very precise temperature readings would be necessary, but the following observation indicated that this was not the case: a 217 ft. pin-connected truss span was watched while the atmospheric temperature was rapidly rising under the warm rays of the morning sun. It was noted that a movement occurred at the roller bearing for every 3 to 5° F. rise in temperature, and whenever such a movement occurred there was a loud noise. The bridge and its bearings were in good condition. It is concluded from the observation that, even under nearly ideal conditions of free movement, the expansion movement of a bridge does not take place smoothly and continuously. If this is true, great precision in the temperature readings is an unnecessary refinement, adding nothing to the accuracy



of the final results. The noise accompanying the successive expansion movements suggests that there was an accumulation of expansion stress in the bridge prior to a movement.

The temperature readings were therefore confined to readings of the air temperature. In a few cases the bulb of the thermometer was in actual contact with the steel, but the readings then were practically the same as the readings taken with the thermometer bulb free from the bridge. It may be true, perhaps, that the actual temperature of the steel is somewhat lower an hour after sunrise than the temperature of the surrounding air (or, similarly, higher than air temperature an hour after sunset); but the observations were all taken between 10 a.m. and 5 p.m., and during this part of the day it is believed that the internal temperature of the steel and the temperature of the surrounding air are very closely the same, in view of the large exposed surface of bridge members and the rapid transmission of heat through iron. Moreover, any attempt at accuracy in measuring the temperature of the steel would be nullified by the fact that at any time of the day some parts of a bridge are shaded while others are exposed to the direct rays of the sun, which makes it a question at what point of

the bridge the temperature of the steel is to be determined.

The readings of air temperature were taken by an accurate Fahrenheit thermometer read to the nearest degree. The temperature reading was recorded, together with the time, etc., on the same page of the notebook where the roller measurements were recorded. Other data noted on this same page were length of bridge, diameter of rollers, date of erection, etc.

The following table gives the results as regards coefficient of expansion obtained from the three classes of bridges observed upon. These three values, while differing somewhat among themselves, are closely enough in agreement with the generally accepted coefficient of expansion of steel to warrant the conclusion that *a bridge expands just like a solid bar.* Whether the lower value obtained for the pin-connected trusses is due to play in the joints may be a matter of opinion.

EXPANSION COEFFICIENT OF STEEL RAILWAY BRIDGES

Number of observations	Type of bridge	Average variation in temperature	Observed coefficient of expansion
16	Pin-connected	39° F.	0.0000053
11	Riveted	30° F.	0.0000064
18	Plate-girder	44° F.	0.0000063

Conclusions

(1) The coefficient of expansion for an assembled bridge structure is practically the same as the laboratory coefficient of a specimen of the same material.

(2) Expansion bearings of steel segmental rollers 5 to 7 in. in diameter properly connected by parallel side-bars and rolling between planed steel surfaces are effective and will take care of all expansion and contraction with at best a very slight amount of secondary stress in the members of the bridge. From other observations, however, it is concluded at the same time that rollers less than 2½ in. in diameter under light steel highway bridges are not effective for any length of time.

(3) A steel cog or other mechanical device to connect the rollers with the bearing plates in such a way as to compel them to turn is unnecessary. The observations showed that rollers without this device acted with just as much freedom as those having it. In neither case was there any sliding.

Improper Placing of Rollers in Erection

During the observations described above, the roller bearing of one bridge (not included in the series reported above) was found with the rollers in such tight contact that it was difficult to detect any parting line between them. This was observed at a temperature of 27° F., and the axes of the segmental rollers were inclined away from the middle of the bridge, so that it was quite out of the question for the bearing to accommodate a further increase in truss length. This bridge was 160 ft. in span, a heavy double-track bridge erected about five years ago. The rollers were 6 in. in diameter. The position of the rollers was doubtless due to carelessness on the part of the erector when setting the rollers. It is easy to imagine that when the temperature rises to 100° F. this bridge will be compelled to slide on its bearing plates.

Erectors should be cautioned to give the setting of the rollers careful attention, and to set the rollers according to the temperature at the time of erection, so that the maximum elongation and contraction counted upon can actually be accommodated.

Roller nests under bridge trusses are machines—a combination of moving parts—to perform certain work. They should have the same attention and consideration as any other machine exposed to the weather. Owing to the fact that the position of rollers makes them practically inaccessible after erection they receive little or no attention during the life of a bridge. In winter they are surrounded by snow and ice which thaws and keeps them moist. Usually there is little provision for drainage and the conditions for corrosion are ideal. Sometimes sticks and stones get into the roller nest and help to prevent movement. Bearings should be designed so that these conditions will be avoided. Maintenance cannot be depended upon to keep roller nests in perfect condition.

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Kelp as a Source of Potash and as a Fertilizer in the United States was discussed by F. K. Cameron, of the Department of Agriculture, Washington, D. C., in the October "Journal" of the Franklin Institute of Philadelphia. The brown algae found on the Pacific coast of North America, and known locally as "giant kelp," have an exceptionally high content of potassium. Investigations extending since 1910 have resulted in the preparation of working maps of kelp groves, aggregating 230 sq.mi., which reach from the United States shore line of Puget Sound to the Cedros Islands of Mexico.

Kelp, when cut and allowed to lie in the water, soon loses its high content of potash. The leaching commences at once after cutting, so that the kelp should be removed from the sea and drained as soon as practicable after cutting. Even though lying in a strong brine, such as sea water, the cut kelp soon decays. When cut and exposed to the air it loses water readily, the tissues shrivel, and on the surface appears an incrustation of the salt mixture, mainly potassium and sodium chlorides, the former predominating. The salt mixture is easily shaken from the dry plants. In commercial practice an artificial drying process is probably the most practical.

Freshly cut kelp has a high value as a manure, but it will never be of commercial importance, as it is not profitable to pay freight on its large content of water. It now appears that the most desirable utilization of the giant kelp is to dry and grind it. The substance thus obtained is in an ideal mechanical condition for use as a fertilizer. Laboratory tests as to the value of this product as fertilizer, show from 15 to 19% potash (K_2O), and 2% nitrogen. The preparation of pure potassium chlorate, iodine, etc., from the residue, may ultimately be practicable and profitable. Kelp can be harvested best at present by means of a flat-decked barge over one end of which projects an endless belt device, 16 ft. wide, and extending into the water to a depth of about 4 ft. At the submerged end of this belt is a horizontal scythe blade at each end of which is a perpendicular blade, each fitted with a gear device to give it a cutting motion, with 4-in. strokes. The inboard end of the belt extends over a hopper, at the bottom of which is a set of revolving blades such as used in the ordinary lawn mower. Below these blades is the end of a belt conveyor on a frame, which extends out from the side of the float and over a towing barge. The kelp, as it is cut, falls on the endless belt, is carried to the hopper where it is cut into 6-in. lengths and then conveyed over the side to the towing barge. With an equipment of one cutter, hoppers cutting 500 tons per 8-hour day, two 85-ton barges, two launches for moving the barges, and a total crew of 6 men, it is estimated that green kelp can be harvested for 40c. per ton. This equipment, with a plant of sufficient capacity to handle its production, would cost about $60,000. The cost to produce 75 tons of dried kelp (equivalent to 500 tons of green kelp) is as follows: harvesting, $200; drying, $45; packing, $75; miscellaneous, $50; total, $370, or $4.93 per ton. The selling price per ton is estimated at about $14.75. The following tabulation gives a comparison of the composition of wet kelp with other manurial products:

	Moisture, Per Cent.	Nitrogen, Per Cent.	Potash, Per Cent.	Phosphoric acid, Per Cent.
Horse manure:[1]				
Solid fresh excrement	.....	0.44	0.35	0.17
Fresh urine	.....	1.55	1.50	.....
Stable manure[1]	73.27	0.50	0.60	0.30
Green alfalfa[1]	75.30	0.72	0.45	0.15
Cowpeas[1]	78.81	0.27	0.31	0.98
Garbage-tankage[2]	.....	0.70	0.30	0.60
Street sweepings, Washington, D. C.[3]	.....	0.86	0.55	0.55
Wet kelp	85.00	0.30	2.50	0.20

[1]From Soils, by S. W. Fletcher.
[2]From Fertilizers and Crops, by L. L. Van Slyke.
[3]From Analyses, by J. G. Smith, Bureau of Soils.

Engineering Principles Applied to Farm Irrigation

By A. L. Harris*

In the arid West, a farmer's system of irrigating ditches is a very important part of his equipment for the growing of crops. Those who have had occasion to notice farming methods in irrigated districts cannot fail to see that much more progress has been made in machinery for cultivating, planting and harvesting, than in the equipment for handling the irrigating water—an operation that must be done oftener than any other. Up-to-date seeders, gang plows, diskers, mowing machines and harvesters do not match well with the crude earth ditches and canvas "tapons" usually met with.

A great deal of engineering talent has been employed on the construction of great dams and distributing systems which collect the water and conduct it to the boundaries of individual farms. Here the engineers have generally left it. Perhaps the reason for this has been that the practical engineer felt himself getting too close to agricultural questions, with which he should not meddle. The fact is, he needs to make a friend of the agriculturist and get a sympathetic idea of his requirements and the rest of his work will be found to consist chiefly of mechanical and hydraulic problems.

It is gratifying to note that some engineers have already impressed irrigation people with the advisability of following scientific principles in the application of water to their land.

It may be explained that different crops require different ways of applying the water. Alfalfa and grain are generally irrigated by flooding. Potatoes, fruit trees, cotton, etc., by small streams in furrows. The choice in this matter belongs to the farmer. In either case, the land is often divided into long parallel strips called "lands" by throwing up small ridges known as "borders" from 25 ft. to 50 ft. apart. The water is turned in at the higher end of the land and if the ground is well leveled it will spread from one border to the next and flow among the stalks of the crop as a sheet, until it reaches the lower end of a "land" and goes into a waste ditch, or until it has been absorbed into the ground. If furrows are used, a small stream runs in each furrow and soaks through the soil to the roots of the crop, which is planted on the side of the furrow, or in the ridge between furrows.

The "header ditch" is the source from which the water is admitted to the "land" or furrow at its higher end. The header ditch usually runs at right angles to the direction of "lands" and furrows. It must have a slope and be of sufficient capacity. Lateral ditches connect from one header ditch to the next to carry the main supply. These laterals must be placed on the high ground so that the water will pass from them and be carried on by the header ditches.

Sometimes in starting his ranch the owner has called in a surveyor to run a level line over the route that he has already chosen for his ditches. Often he will dig the ditch first and then try it. It is not at all uncommon to hear a rancher say that he believes he ought to have had his "lands" run in another direction; a change that would call for an entire reconstruction of his ditches and irrigating system. He probably does not know that a very reasonable outlay for engineering will provide a map with 1-ft. contours upon which can be laid out beforehand, certainly and accurately, the most economical plan for ditches and irrigating system. The best slope for irrigating and the best for header and lateral ditches can then be selected and dimensions chosen.

Very seldom is ground exactly even by nature. Much money is put into "leveling." It is usually done with drags and scrapers and trued by eye, and then proven by running the water onto it. Expensive mistakes are made in this way. In a recent instance a principal header ditch was put in with expensive earthwork and all preparations made for planting, when it was found that the water would not run in the ditch, because the ditch passed over a deceptive ridge in the ground. It was found necessary to go to another canal for a supply and feed the header ditch on top of the ridge, from which point the water was run in either direction.

Notice a typical ranch at irrigating time (see Fig. 1). Water is turned by the "Zanjero," or water boss, into the first header ditch on the higher end of the ranch, in quantity such as the farmer thinks he needs, a "whole head," "half a head," or perhaps a "double head," and is continued for a period agreed upon. The head varies in different localities; say from 5 to 12 sec.-ft. (cu. ft. per sec.).

Previous to the arrival of the water, the earth ditches must have had a going over to prepare them for the flow. Weeds grow most luxuriantly in them as they retain moisture and furnish a fine soft soil. The water being generally laden with silt, there are many places where the deposits must be shoveled out. Poles and canvas for "tapons," rubber boots and shovels are the implements.

The irrigator takes his canvas and wooden pieces down the header ditch, a space of three or four "lands," and throws in his "tapon"—a Spanish word meaning "plug"—to check up the water and little openings are shoveled in the bank of the ditch at the head of each "land" to allow the water to flow out and wet the ground. The irrigator then plods along in his rubber boots with the advancing water, down the "lands" to make little dams and furrows with his shovel for the purpose of spreading the stream evenly over all parts of the ground. He may, quite likely, be called upon to leave his irrigating and go back to the header ditch to stop a break in the banks, or to hunt and plug up a gopher hole. It is a heavy job, shoveling soggy earth, and one also requiring skill, as well as muscle. Often it must be done at night by the light of a lantern for the main canals must run continually, and each farmer takes his water in rotation. An experienced hand knows many little tricks about "handling water" that help to make a large amount of this labor endurable. Many a hard-working conscientious laborer with plenty of muscle but limited experience has "fought the water" until utterly discouraged and beaten. By those accustomed to judge the size of a stream of water, it will easily be admitted that to stop and divert, with a piece of canvas, some sticks and a shovel 10 sec.-ft., or 400 miner's inches, of water flowing at 2 or 3 ft. per sec. velocity, is certainly a job for a physically capable man. A good irrigator for such conditions is hard to find.

A "borrow ditch" of earth is a terror to the irrigator. A "borrow ditch" is one which, on account of a sag in

*Engineer, Fleming Building, Phoenix, Ariz.

the ground, must carry the water considerably above the natural surface, by means of banks built up to retain the water. Gophers pierce the banks with their burrows and the bank will often melt and open up a small crevasse in an incredibly short time. A small increase in the amount of water flowing will sometimes overtop the bank slightly and the result is the same.

On account of the frequent necessary cleanings, the earth banks are increased in size by the accummulation of silt shoveled out, until an old earth ditch of small capacity is found to take up 15 or 20 ft. of width; thus excluding so much land from the producing area. Two to four acres of ground is commonly occupied by the header ditches and laterals of a 160-acre homestead. Borrow ditches take more room than the commoner kind.

Many ranchers who are not satisfied with old-style methods improve things somewhat by placing wooden boxes with a sliding board to control the outlets at the heads of "lands" and some place more or less permanent "tapons" of boards across their header ditches for checking up the water. These help matters considerably, but are at best short lived and hard to maintain.

FIG. 1. COMMON EARTH DITCH IRRIGATION

FIG. 2. PIPE AND STANDPIPE SYSTEM FOR ORCHARD IRRIGATION

ENGINEERING PRINCIPLES APPLIED

As in so many lines of modern science and modern business which the persistent application of a few physical principles and a thorough respect for details have raised up from a condition of crude disorder and wastefulness to one of harmonious efficiency, so in farm irrigation a few hydraulic and structural principles, applied by one who understands them, will greatly increase the benefits and reduce the labor and costs. The ideas are well set forth in works on irrigation, but are easier to grasp than to carry into effect.

First, as hinted before, a complete topographic plat of the ranch with 1 ft. or less contours should be made and the most economical scheme of leveling or rather evening the ground should be worked out, with due respect to the choice of an irrigating slope and a conducting system for supplying the water. These problems in grades and plan sometimes furnish a surprisingly difficult study. For leveling, stakes can be given that will greatly help the leveler and do away with the cut-and-try method.

There are considerations affecting the direction of "lands" and grades for irrigating other than velocity and washing of the soil. Adobe or clay land will absorb the water slowly, making a flatter grade in the direction of the irrigating flow more desirable. The water will then have more time to soak in as it flows down the slope. A loose sandy soil, on the other hand, if too flat, will take a great deal of water and perhaps make it difficult to force the water to the end of a "land." The plants need about a certain quantity of water in either case. The water in many cases at present and more generally for the future must be paid for on the basis of quantity used. The irrigating scheme should therefore be adapted to furnish all necessary amounts, but to prevent waste.

Just as one of the very best business principles is to keep a good set of accounts so is it best for the irrigator to know how much water he is using. Some fairly accurate weir, rated channel or other device could be selected and explained by the engineer, unless indeed he may be able to introduce a reliable automatic meter of some kind that works when the farmer forgets it. Even though the Reclamation Service or the company measures the water to him, he will appreciate better a measurement of his own, for he may have the result at once, and check up with the service officers on occasion. Water is one of the materials that go into the manufacture of his products. Why should he be more ignorant, from the beginning of a season to the end, of what expense he is pouring in with the water than of that he is devoting to labor or to seed? There will be found many ways of saving as he goes along when the outlays are known.

Good engineering naturally looks to permanence for an equipment that must be used over and over. With good grades chosen, good leveling done and a substantially built conducting system that runs the water in definite channels of even grade and certain control, we are sure of improved results.

The conducting system should be made to withstand erosion and so far as possible be self-cleaning. The beneficial results that may be expected from these improvements include reduction of labor in irrigating, saving of water, time and land area, and facility in operation. There are agricultural benefits also, such as

the prevention of weed growths on ditch banks. Irrigating water makes a most efficient disseminator of noxious seeds.

Progress

Some of the work that has been done in pursuance of this subject has been both interesting and successful. In

Fig. 3. Concrete-Lined Header Ditch, Arizona
(The irrigation water discharges over the edge to the left.)

the California fruit orchards, where irrigating water is usually clear, and crop values very great, elaborate underground pipe systems for distribution have been perfected. The source of water and grades are so related as to place a low pressure head on the pipes and the water is drawn through valves set in risers that come out of the ground at intervals. The pipes are made of both concrete and clay tile. Where the smaller quantities of clear water are to be handled, and the irrigating is done in rows, a well built system of this sort seems almost ideal (Fig. 2). However, many farmers, fascinated by the refinements of the system and unwisely out of touch with engineering advice, have failed to see the limitations of the system and have tried to introduce it where quantities of water must be much greater; where the water carries much silt and sand, and where the class of crops to be raised is of much lower value. It is thus seen that, as usual, the engineer's problem is to fit the works to the service in an economical sense, as well as in a mechanical one.

When the requirements for orchards, as in southern California, may call for an 8- to 14-in. pipe for the header conduits it is a simple and not unduly expensive thing to place these pipes deep enough in the ground to clear the plow point; but if for alfalfa fields, as in southern Arizona, where rainfall and humidity are very scant and evaporation very great, the call is for a 20- or 24-in. pipe, the case becomes different. The excavation increases, the price of handling mounts up, and the original cost of the pipe becomes about three times greater. But the Arizona man who has visited in California has perhaps selected his sizes from California and the results in service are disappointing. He cannot get the necessary "irrigating head" through his system. Also unless the works have been planned and put in by some one who appreciates the necessity of preventing the entrance of drift into the pipes, and unless the farmer attends to frequent thorough flushing out of silt deposits, choking occurs, which is another name for much trouble.

Not that pipe systems are in general inapplicable to Arizona irrigating conditions but that engineering discretion is needed to determine when and where, and that special precautions and adaptations must be made.

In Arizona there has been some interesting work done in providing improved ditches. These are of uniform trapezoidal cross-section, with even grades, and are lined with concrete. The value of the n coefficient of roughness is reduced to about 0.012 and the farmer accustomed to earth ditches is often astonished at the reduction in size and room required for such a ditch of the usual capacity. Where considerable natural grade is available, much higher velocities are made possible without ill effect. The ditch may also be a "borrow" one without risk. Gophers cannot penetrate and weeds cannot grow in the channel.

With this method of conducting the water there has been incorporated a system of checking and delivering to the land that pretty nearly satisfies all requirements for the peculiar field irrigation conditions of the district (Fig. 3). The side slopes are selected at 45° on the principle that this is about the angle of repose of the earth which forms its support, thus permitting the use of a light lining. A board or flat sheet of metal cut in such a trapezoidal shape as to fit an inside transverse section of the ditch taken at about 50° to the axis will serve as a check, without attachments in any part of the ditch. The water pressing normally upon it on one side, will hold it in place (Fig. 4).

For delivering to the crops, no gates are required. On the side where water is to be delivered, the concrete lining is finished along its upper edge in long level steps; the drop of the step being placed opposite each third or fourth border, and made equal to the drop of the ditch grade for that distance. A check board put in just above a step will cause the water to rise and flow over the level

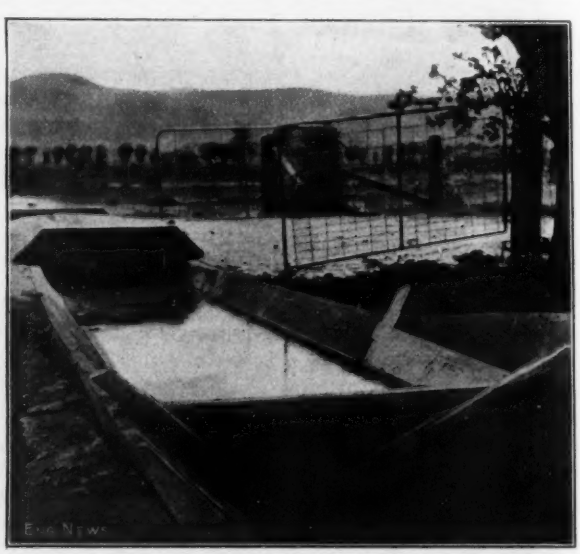


Fig. 4. Check Lift for Concrete-Lined Ditch

side in a thin sheet for a length equal to that of the step (see Fig. 5).

Of course the concrete lining on the opposite side of the ditch must be carried up a few inches higher to prevent overflow in that direction, and so called elevated "lips" are extended upward to a similar height where

the borders meet the ditch on the irrigating side. This idea was first hit upon by the writer, as he believes, and has been successful in application. Besides being simple in principle and operation it has some distinct advantages in other directions. By placing the grade of the ditch low enough to keep these level side crests from zero to 3 in. above the ground, the water flows gently over the full width of a "land," and the crop may grow up to the very edge of the ditch, as seen in Fig. 3. This conserves crop area and puts the ditch in the position of greatest stability.

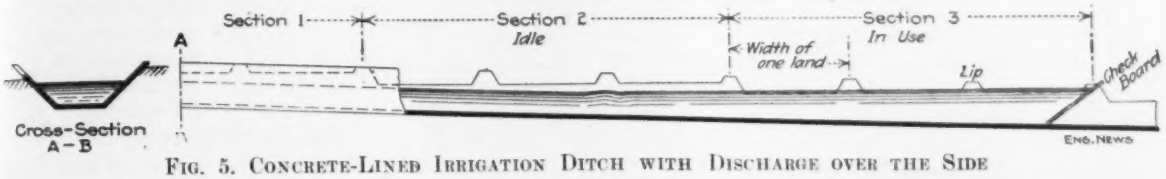


FIG. 5. CONCRETE-LINED IRRIGATION DITCH WITH DISCHARGE OVER THE SIDE

The water is drawn off at its surface. Sand or sunken drift of any kind will stay in the ditch to be collected generally at the lower end, where it is cleaned out when the ditch is dry. Enough room must be allowed in the cross-section to enable the full flow to pass along without running over, when not checked up. Three or four "lands" are irrigated at a time. It is a great advantage to have no gates to operate, other than the simple check. These are light and are used in pairs, one being carried forward down the ditch, and put in place before the one in use is pulled. The work of cleaning such ditches is easy as there is the smooth hard concrete surface to shovel from and no roots or turf to be cut through.

The concrete lining for farm ditches is made 2 in. thick and has been put on by means of forms and by plastering. It is an open question which of the two ways is to be preferred. With proper guide strips and templates, the writer favors the plastering method. He has found simple creases similar to those in sidewalks sufficient for taking care of shrinkage and temperature cracks, which silt up tight. The writer has not seen the lining tried in regions of much frost, but they keep their position very well in southern Arizona. The ground behind them must, of course, be made firm before placing. As to cost, it is found that the ditches carry the required heads for alfalfa in Arizona for about one-third the cost of concrete-pipe systems of equal capacity.

Many private concrete headgate structures, division boxes and culverts have been put in, following the example of the Government works in large canals. When well designed and constructed they are of great benefit, even when the expense of better ditches or pipe cannot be borne.

All this work is of a light character and the jobs are necessarily scattered over considerable territory. It is often a considerable distance to materials and source of supply. Trade labor is also hard to get and keep in such surroundings. These considerations cause contractors to shy at this kind of work or to make too high prices. Yet it should be possible to overcome these difficulties by the use of automobiles; supplying good portable board and lodging equipment; standardizing the work and forming neighborhood syndicates of farmers for the purposes of contract.

Efforts should be concentrated in the direction of cheapening. The expense at present in labor is about equal to that in materials. Quick mechanical methods for putting in ditch linings need to be perfected. Some cheap method of destroying or preventing the germination of weeds along canal banks, and of eliminating drifting sand in the water, should be devised.

Costs

It is often difficult to convince a farmer that it pays to invest in such equipment as has been described, and even when convinced that the principles are sound it may be impossible for him to raise the funds required for construction. An investment of $25 or $30 per acre in a farm-irrigating system, which is roughly what is required for concrete-ditch systems at present, is not an inconsiderable sum for the average farmer to raise. But the important question, "is it worth the cost"? decides the matter. If worth while, and the same can be convincingly shown, a way of financing will be found.

However roughly, wastefully and awkwardly, as a profit-producing business, farming may have been done in the past, and however unwisely "independent" the farmer has been, the signs are good that the great movements toward union and conservation of effort so characteristic of other business are about to reach agriculture. Why not Water Users Associations for the purpose of financing individual farm-irrigation improvements?

Our opinion drawn from investigations in Arizona is that the new farm systems pay well for the investment and that the future will see them in more and more general use. The old laborious ways will some days not be tolerated by the average farmer. The practical engineer will be in closer touch with the practical farmer, and both will find it profitable that the former solve the problems which fall in his line. He will often surprise and delight the farmer with ingenious and profit-producing devices to make irrigating time one of accomplishment and satisfaction.

The Age of Extravagance—According to figures compiled by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, the national debts of the world now aggregate 42 billion dolars, having increased 20% in the last decade and doubled in the last 40 years. The interest and other annual charges amounted in 1912 to 1732 million dollars.

The largest national debt is that of France, 6284 million dollars; the next largest being Russia, 4553 million; the United Kingdom, 3486 million; Italy, 2707 million; Spain, 1815 million; British India, 1475 million; Japan, 1242 million, and the United States, 1028 million. The debt of the German Empire is stated at 1178 million dollars, and of the German States, 3736 million; that of Austria-Hungary, 1051 million; that of Austria, 1434 million, and of Hungary, 1268 million dollars.

Practically all the important countries show an increase in national indebtedness in 1912 compared with 1902. In the case of France, the figures for 1912 are 6284 million, against 5857 million in 1902; Russia, 4553 million in 1913, against 3414 million in 1903; Japan, 1242 million in 1913, against 262 million in 1902; the German Empire, 1178 million in 1912, against 699 million in 1902; the German States, 3736 million in 1912, against 2688 million in 1902; the United States, 1028 million in 1913, against 925 million in 1903. The United Kingdom shows a slight decrease, the figures for 1913 being 3486 million dollars, against 3885 million a decade earlier.

A Large Tunneling Shield; Steel-Channel Tunnel Lining

Several innovations in tunneling practice characterize the recent construction of the Elm tunnel on the Frankfurt-Berlin railway line, Germany. They are set forth in the following description, based on information obtained from the contractors, Grün & Bilfinger, Mannheim.

The tunnel, 2.2 mi. long, lies for most of its length in sandstone. Near each end, however, there are soft-ground sections where the soil has very little stability; the ground is treacherous, settlements and slow-flowing slips occurring. The rock portion of the tunnel was handled by conventional methods: A bottom heading was driven, and from it the full section excavation was handled by making breakups, excavating the arch, placing caps and two sets of radial-arch struts (according to the Austrian method of timbering) to hold the roof, and finally removing the side benches. This work is very well shown in the photographic view Fig. 1 herewith. The soft-ground sections, however, were not amenable to this method of construction, and had to be handled by special procedure.

In driving the bottom heading, the clay ground had been found to be subject to squeezing. In the rock, only the usual light timbering which the bottom-heading method always requires was placed, but in the clay the heaviest wooden timbering was inadequate and finally, after much trouble by squeezing and breaking of the timbering, steel I-beam sets were put in, about 3 ft. apart. This steel timbering was as heavy and as closely spaced as was used in the worst sections of the headings of the first Simplon tunnel, in spite of the shallow cover—[illegible] to 160 ft. The great pressure exerted was chargeable to sliding which probably extended up to the surface.

Under these pressure conditions the contractors believed that the full section excavation could not be taken care of by any method of timbering known. Shields were decided upon as the best way to carry the work through. A shield was built for each end of the tunnel (to save time), at a cost of about $50,000 per shield. Fig. 3 shows one of the shields and the work immediately back of it, with steel sets showing in the background.

These shields were 37½ ft. wide out to out and 35½ ft. high. Thus they are the largest tunneling shields ever built or used. In addition, it is to be noted that they are not circular but horseshoe shaped, a form usually thought to involve difficulties in driving, on account of the tendency to turn around the longitudinal axis, or rather the difficulty of restoring the shield in case it should turn. However, no trouble was experienced in keeping these shields straight.

The shields had very short tail, the overall length being only 14 ft. In part, this is accounted for by the type of lining used. The lining placed immediately back of the shield as outer skin (inside of which the brick lining was laid up) consisted of 12-in. channels laid flat, flanges in. The channels were cut and bent to form segments of the tunnel curve and were set together in the tunnel by bolting through the flanges, joints in adjoining rings being staggered. Apparently no splices were used at the end-joints of the channel. The lining can be seen in the view, Fig. 3.

The shields were used without compressed air; conditions did not call for air, but it could have been put

FIG. 1. ELM TUNNEL; FULL-SECTION WORK BY AUSTRIAN METHOD

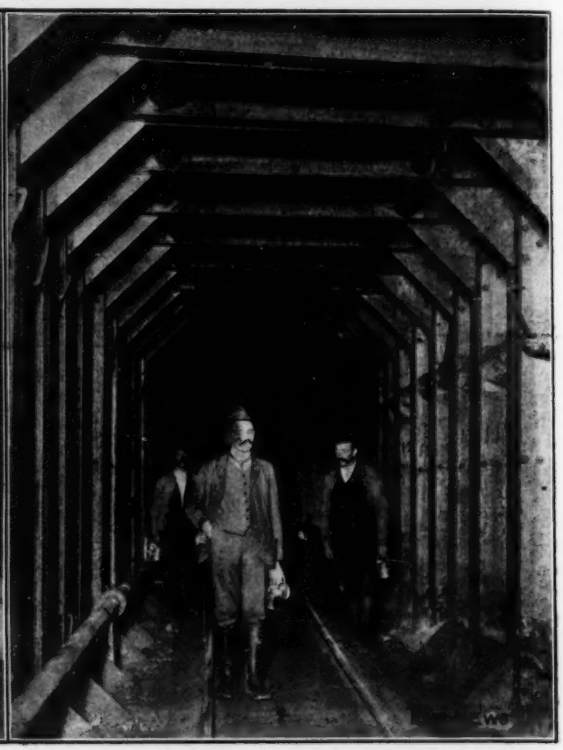


FIG. 2. HEADING THROUGH SQUEEZE SECTION, WITH STEEL SETS

on when necessary, by building a bulkhead and airlock back of the shield. The clay soil, while treacherous, stood up sufficiently well during short-time exposure that there was no particular difficulty at the face, and it was possible to excavate in front of the cutting edge, so that the shields did not have to be forced into the soil by the jacks. The tendency of the clay to flow slowly did not affect this part of the work.

In spite of the short length of the tunnel, the desire to hurry its construction led to making the attack from two shafts in addition to the portal attacks, thus giving five working points. The tunnel was completed two years ago and is now in service.

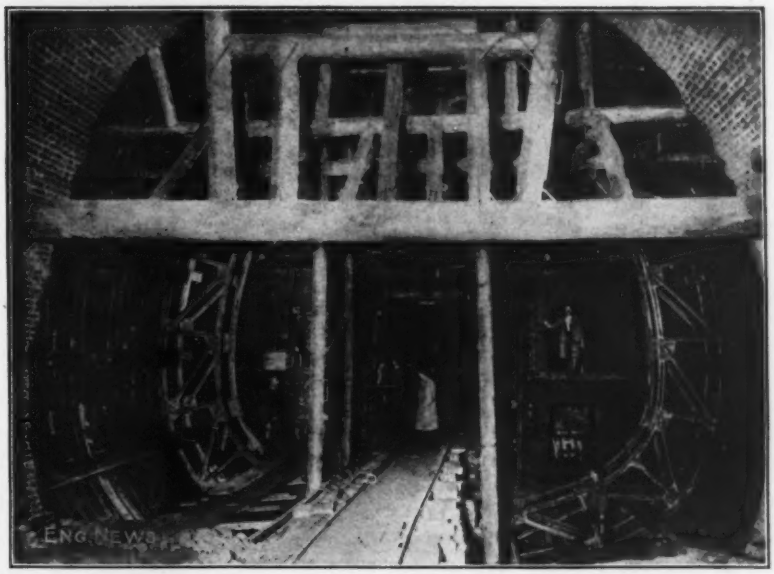


FIG. 3. FULL-SECTION EXCAVATION WITH SHIELD IN SQUEEZE SECTION, SOUTH END OF ELM TUNNEL; STEEL-CHANNEL LINING

(Shield used for full-section excavation only. Bottom heading was completely driven in advance, and lined with steel square sets.)

The Interstate Commerce Commission Report on the Derailment near Stockwell, Ind., on Jan. 7, 1913

The derailment of a passenger train on the Cleveland, Cincinnati, Chicago & St. Louis R.R., on Jan. 7, 1913, near Stockwell, Ind., which resulted in the death of one passenger and the injury of 66 others and 4 employees, was recently reported upon by Chief Inspector Belnap, of the Interstate Commerce Commission, Washington, D. C., and J. E. Howard, Engineer-Physicist of the Bureau of Standards. The cause of the derailment was found to be a broken tire on one of the wheels of the forward truck of the second car from the locomotive. Inspections of the wheels of the cars of this train were made at Cincinnati, and Indianapolis, on the day previous. The superintendent of motive power of the railroad stated that the most approved method of inspecting car wheels was by observation, and that it was the practice of the company to select car inspectors from the repair men. He said that this defective wheel was a single-plate solid-center steel-tire wheel; the tire was applied by shrinkage, and there were two retaining rings, one on each side, held in position by 10 or 12 rivets.

In his report, the engineer-physicist stated that the character of the fracture led him to believe that it was the extension of an old thermal crack. The shrinkage of the tire upon the wheel center was the chief element which kept the tire in place. When fractured, this resistance was lost, and only the strength of the rivets of the retaining rings would then be available for holding it in place. The successive side lurches of the car overcame the strength of the rivets by flange blows, ultimately forcing the tire off the wheel center.

Thermal cracks in the steel tire were formed by the heating of the wheel-treads by the sudden application of the brakes, which resulted in high temperatures and the temporary reduction of shrinkage resistance. The tire exhibited on its tread many such thermal cracks. The fractured tire was made by the Midvale Steel Co. It was originally $3\frac{1}{8}$ in. thick and had worn to $2\frac{9}{16}$ in. at the time of its failure. The total mileage made was 111,113 miles. The car was in the shop in March, 1912, when the tires were trued up.

In his concluding remarks, the chief inspector of safety appliances calls attention to certain derailment statistics included in his report which show that of the 14,563 accidents traceable to defective equipment, which occurred in the United States from 1908 to 1912 inclusive, 9341, or 36%, were due to defective wheels, while 16% of all derailments during this five-year period resulted from the same cause. These statistics indicate the alarming frequency of accidents due to defective wheels and the seriousness of the problem confronting railroad companies in securing sound wheels and providing an adequate system of inspection, which will insure that the defective wheels will not be placed or remain in service, and that worn wheels will be removed from service in ample time to provide for the safe operations of trains

Experiments on the Water-tightness of plain, untreated concrete are being carried on in great detail at the College of Engineering of the University of Wisconsin. The series is not completed but it is stated that those tests which have been made show that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed, but that for cases where the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments showed that mixtures consisting of 1 part of cement, $1\frac{1}{2}$ parts of Janesville sand of the torpedo grade, and 3 parts of Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 lb. per sq.in. Mixtures as lean as 1 part of cement to 6 parts of gravel (a graded mixture) have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch. The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are $13\frac{1}{2}$ in. in diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 to 18 in. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus.

The department is also studying the effect of varying the percentages of cement and water, the gradation of the sand and gravel, the proportioning of the mixture, the thoroughness of mixing, on the hardening of the specimens.

A Tile Protection for Intertidal Concrete in Sea Walls

The destruction of concrete exposed to sea water has been made the subject of much experimental study on both test pieces and full size construction. While there is some doubt as to the general effect of sea water on concrete, it seems to be well proved that the intertidal face of a concrete sea wall has a very short life, particularly in northern climates where the wall is subjected to alternate freezing and drying and the battering of floating ice. The general conclusion made by engineers familiar with concrete work in northern latitudes is that this action is practically entirely a physical one and is not due to any chemical processes, such as the making of new salts from a combination of the salts in the cement and those in the sea water. Many examples may be cited where a well built concrete wall in a northern climate made up of the best of materials has shown pronounced disintegration in the intertidal face while the remainder of the wall is in very good condition.

The accompanying view (Fig. 1) shows a portion of a sea wall on the Nova Scotia Coast. This wall is exposed to wetting and drying and freezing and thawing in the intertidal space, which is practically between *A* and *B* on the left of the view. After about the third year of its existence the disintegration in this intertidal space began to be very marked and the rate of destruction increased at about ½ to ¾ in. in depth per year after that time. The failure became so pronounced that the vitrified brick face wall shown at the left of the view, was placed about 1891. This facing was not built up high enough, for the deterioration shown above the brick has occurred since 1891. In 1911 the concrete-block facing shown at *C* on the right was placed as a further protection to the intertidal space. Although not shown on the view, the faces of these concrete blocks already show signs of scaling.

In order to provide a surface to concrete sea walls that would be practically free from the above noted disintegration, William B. Mackenzie, Right-of-way and lease agent of the Intercolonial Ry. of Canada, with headquarters at Moncton, N. B., has devised and patented a method for protecting such concrete walls, in which the intertidal face is made of hollow vitrified salt-glazed tile blocks filled with concrete.

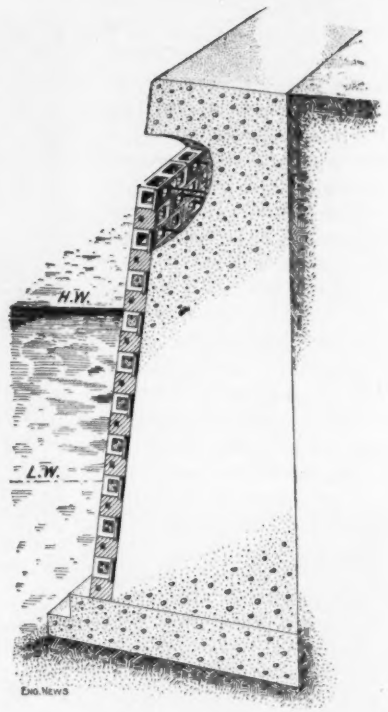


FIG. 2. PERSPECTIVE VIEW OF HOLLOW-TILE CLAY-BLOCK PROTECTION FOR SEA WALL

Fig. 2 shows the details of these blocks. As will be noted in the figure they are laid in regular courses from a point slightly below the low-water line to one slightly above the high-water line. The blocks are somewhat sim-

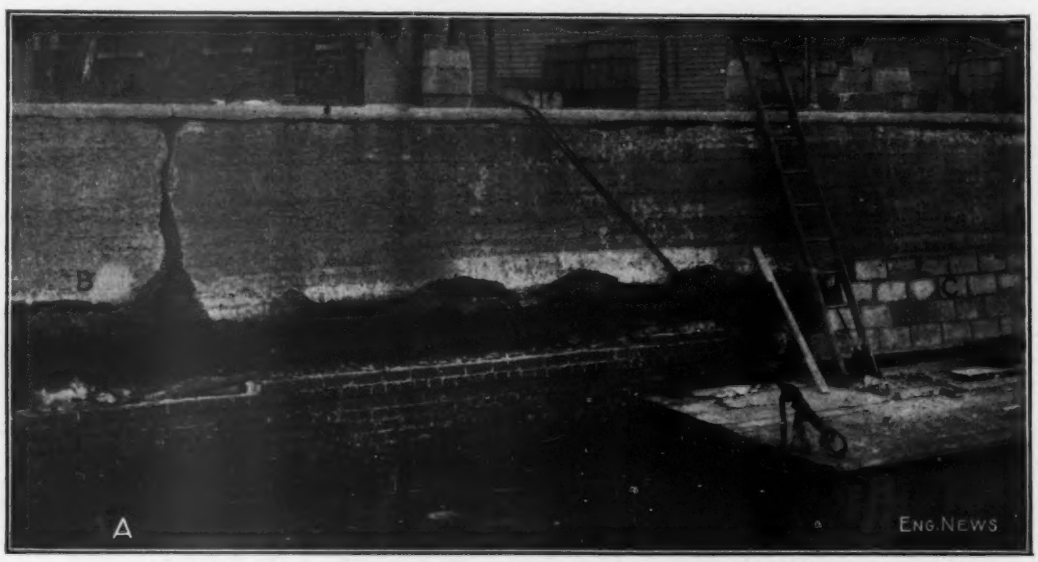


FIG. 1. A CONCRETE SEA WALL ON THE NOVA SCOTIA COAST

(Tide rise A to B. Vitrified brick face on left placed 1891; concrete block face on right placed 1911.)

ilar to the ordinary hollow-tile building blocks. It is the intention of the inventor to have all webs of the blocks about 1 in. in thickness except the front and center web, which will be 2 in. in thickness. The blocks are to have the ordinary size of 8x8x16 in., and are to be provided (in distinction to the ordinary building blocks) with large holes at the back and the ends.

In construction the blocks are to be placed first in their proper position along the faces of the wall and are to be set up in mortar and bonded together at a projection at the back of the block. They are further to be tied together with the rods shown as a precaution against separation when the concrete is placed behind them. After they have reached a certain height, the concrete is to be poured in back of them, using the tile as a form. This concrete will not only go up against the back of the block, but on account of the openings left in the back and ends, will flow freely into the insides of the blocks, making a perfect bond between the block and the concrete. The finished wall will then show a vitrified salt-glazed clay face which will be 2 in. thick and which will be backed by the regular solid concrete wall.

So far as any experiments or observations have shown, vitrified salt-glazed tile is impervious to any deteriorating action of sea water and has an effective structure against the battering of ice; further it is so dense as to preclude the possibility of any water entering and freezing in it to the consequent destruction of the tile.

Further Data on the Collapse of the Water-Works Partition Wall at Fort Smith, Ark.

The accompanying drawing and further information bearing upon the failure of the thin partition wall in the 5,000,000-gal. settling basin at the municipal water-works plant at Fort Smith, Ark. (ENG. NEWS, Nov. 20, p. 1049), has been sent us by the designer, Wynkoop Kiersted, consulting engineer, Kansas City, Mo. The following statement is taken from Mr. Kiersted's report, dated Oct. 30, upon the accident, to the Chairman of the Board of Improvement, of Fort Smith.

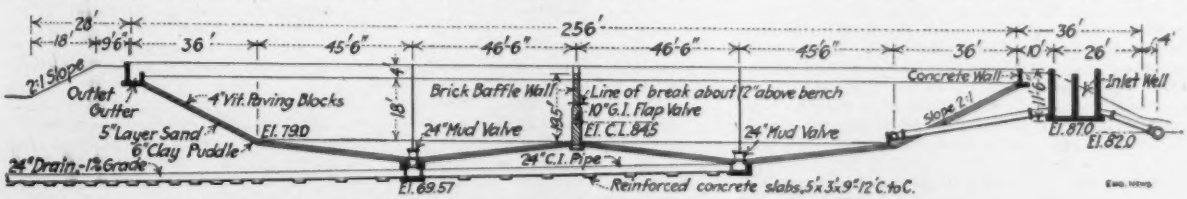
The object of this wall across the middle of the settling basin is to provide facilities for introducing a coagulant after the water has deposited the heavy sediment in the east division of the basin. To have built a wall solely for this purpose, which would be strong enough to empty either division of the basin independently, would have been too expensive, costing $7000 or more. Therefore we conceived the idea that a baffle wall would answer every practical purpose. In the design of this baffle wall the fundamental consideration was kept in mind, viz.: that no settling basin constructed of earth embankment should be emptied rapidly. This is because rapid emptying exposes the earth banks, which are more or less saturated, and the paving of the inside slopes, to the danger of sliding.

The baffle wall was, therefore, designed for stability when the reservoir was full, with 8 in. difference of level of water on either side of the wall. The four pipes through the baffle wall, at a level of about 5 ft. 6 in. above the bottom of the reservoir, admit of a discharge at the rate of about 6,000,000 gal. per 24 hours with an 8-in. difference in water level. As the water level in the basin lowers, the permissible difference of level becomes greater; and finally, when the level of the water reaches the cross pipes, a difference of 5 or 6 ft. would be admissible.

The drain pipe from the basin to the river is 24 in. in diameter and communicates with each of the two divisions of the basin by means of two 24-in. disk valves. The tower over the drain valve in the west division is built low in order to compel the opening of the east valve when necessary to drain the basin; otherwise, if the west valve were opened first the flaps on the cross pipes in the baffle wall would cut off communication between the two divisions. The discharge capacity of this 24-in. valve and 24-in. drain pipe, under the pressure of a full basin, is at the rate of about 35,000,000 gal. per day. It is not easy to control the rate of draining the basin by means of the disk valves, and for this reason a 24-in. stop gate was placed on the drain line outside of the west embankment, the idea being to set the disks of this stop gate at such a point that a rapid emptying of the basin would be impossible. The disks of this valve had not been set, as we did not anticipate any occasion for the early draining of the basin.

From the above explanation I think it will be clear that when the disk valve in the east basin was raised to almost its full height the unobstructed discharge from the east basin so greatly exceeded the discharge from the west basin through the cross pipes that the difference in level between the water on either side of the baffle wall soon passed the 8-in. safety mark, and pushed the lighter portion of the wall over. There was no possible way of avoiding the accident with water passing out of the basin under full head and with a wide open valve.

The short period that the settling basin has been in operation has shown very clearly that the Poteau River water can be thoroughly and economically coagulated by introducing the coagulant at the wall on the east side of the basin, through which the river water passes, and for this reason there is practically no necessity of a second coagulation in the middle of the basin. The occasion for the second coagulation in the middle of the basin is desirable when the Poteau River is flooded by the Arkansas River. The periods of Arkansas River overflow are comparatively short, perhaps not more than 10% of the time, and therefore it seems scarcely necessary to rebuild the baffle wall to its original height for this limited use only. I should not recommend the reconstruction of the wall further than to repair the brickwork at both ends of the portion of the wall which remains upright.



CORRECT CROSS-SECTION OF THE 5,000,000-GAL. SETTLING BASIN

Small Municipal Waste Incinerators for reducing waste paper and other light, bulky and inflammable refuse to ashes before removing it to the public dump, have been decided upon by the City officials of Glendale, Calif., according to the October "Quarterly" of the National Fire Protection Association. The type adopted is 4 ft. square, and the chimney portion is 5 ft. in height. The interior dimensions are 3x3 ft., while the height of the inclosure is about 4 ft. The refuse is fed in through an opening in the upper front side. After the insertion of the waste material, this opening is covered at the top by a screen of 2-in. mesh. The flue, which is 6x27 in., is also covered at the top by a screen, to prevent the escape of any large pieces of the burning material. The fire grate of 1-in. angle iron, is built on the inside of the incinerator, just above the large draft opening. These incinerators cost (erected) about $17 each, and are installed at convenient points in the city. The refuse, swept or carried out of the various establishments, is to be brought to the nearest incinerator immediately after the close of the working day, and the burning will be done during the early night hours, so that the ashes will be sufficiently cooled by morning to be collected by the public carts.

Three Years' Record in Motor-Omnibus Development in London

In recent issues we have published a full abstract of the report on motor-omnibus operation in London and Paris, made to the Board of Estimate of New York City. We now supplement that valuable paper by the following abstract of a report to the International Road Congress in London last summer by Edward S. Shrapnell-Smith, Editor-in-Chief of *The Commercial Motor*.

Three years ago, while the commercial use of motor omnibuses had reached a stage of development at which, for employment upon paved or other impervious road surfaces, all fundamental and practical difficulties of operation had disappeared, the possibility of successful competition with electric tramcars was not admitted in many commercial and engineering circles. The interval between the Brussels Congress and the present Congress has, however, amply demonstrated that the lower running cost per mile of the motor omnibus, its superior mobility, and the greater frequency of service which is possible with the larger number of the smaller units, are factors which have enabled the 34-seated motor omnibus seriously to compete with the 78-seated electric tramcar throughout Greater London.

The majority of the highways upon which London services are conducted are paved with asphalt, granite or wood; certain difficulties have been experienced when the traffic has been taken over water-bound macadam roads. The insufficiency of many water-bound macadam roads to bear motor-omnibus traffic is admitted, but any of the modern systems of waterproof road construction should remove that difficulty, both in London and in country areas.

The following is a statement of the total number of motor omnibuses actually working at the stated dates:

At 31st December, 1909.....	1,049 Motor Omnibuses.
At 31st December, 1910.....	1,097 Motor Omnibuses.
At 31st December, 1911.....	1,634 Motor Omnibuses.
At 30th November, 1912.....	2,527 Motor Omnibuses.

Of the motor omnibuses in service at the end of November last, only 84 were propelled by steam; all the others used internal-combustion engines, and petroleum spirit.

FREQUENCY OF SERVICE—Three motor omnibuses per minute, in each direction, is now a common provision upon the principal central highways of London.

The maximum intensity of motor-omnibus traffic exists in Oxford St., between Bond St. and Oxford Circus. There, at certain times of the day, no fewer than 248 motor omnibuses pass in each direction per hour, yet there is no congestion. The average headway exceeds 70 yd. Sometimes at the picking-up points, if the regulation of the waiting vehicles is not carefully supervised, some congestion does occur, but this is avoidable.

The possible and frequently achieved performance, reckoned in passengers carried per hour past a given point, is shown by the above records of the number of 34-seated motor omnibuses (16 inside passengers and 18 outside passengers), which pass hourly, to be 8,432 seated persons, in each direction per hour, without any overcrowding.

Passengers are not allowed to stand in or on any London motor omnibuses, and there is no platform space at the back, such as is common in Paris and in other Continental cities.

FLUIDITY OF TRAFFIC—The fact that the noted increases in the totals of motor busses have not led to undue congestion in London calls for special comment. The figures of street-mileage and numbers of vehicles disclose an approximate average of ten vehicles in service per mile of route worked, with a downward tendency in 1912, the average at the 30th November, 1912, had fallen to below eight per mile of route worked. This indicates better and careful distribution. The author would direct particular attention to the fact that comparable data for the London County Council electric tramcars show an average of 11.5 of the bigger vehicles per street-mile served.

The average speed of an electric tramcar is at least two miles an hour less than that of a motor bus in London. London motor busses are able to average at least 20 miles of running per working day more than the tramcars do. Hence, seeing that there is a smaller average number of motor busses per mile of street served, and that these vehicles travel at higher average speeds than the tramcars, it will be obvious that the congestion due to tramcars is the greater. The ability of the independent vehicle to draw round obstacles, or to deviate temporarily from a disturbed route, and the absence of delays to the whole system when any failure of individual mechanism occurs, are contributory factors of which the importance is becoming more and more valued by the proprietors, recognized by the police authorities, and appreciated by the traveling public.

PASSENGERS CARRIED—The L. C. C. electric cars have a total capacity of 78 seats, yet the average of passengers per car-mile is approximately the same as the average for the 34-seated motor bus. While the L. C. C. tramcars are completely filled for, perhaps, four journeys each per day, these large units travel about with very few passengers for the rest of the day. In the rusch hours, more motor busses can be provided and worked very much more cheaply than can more tramcars.

It is now made amply clear in London, that 2,650 electric tramcars do not, in practice, carry a proportionally greater aggregate total of passengers than the same number of smaller motor busses. Electric tramcars (2,882 licensed) now carry approximately 2,250,000 passengers per diem, and motor busses (2,810 licensed) 1,850,000 passengers per diem, in London, and the motor bus is increasing its support at the cost of the electric tramcar. The public, in most cases where the choice exists, prefers the motor bus.

FINANCIAL CHANGES SINCE 1909—Although some hundreds of horses are still in use for the haulage of omnibuses in London, the premier company—The London General Omnibus Co., Ltd.—sold its last horse out of service on Oct. 25, 1911.

The financial improvement that has been secured as the result of the working of motor busses by this company is set out in the appended summary.

REDUCTIONS IN THE WORKING COST OF LONDON MOTOR BUSSES

Year ending Sept. 30, 1909.....	1.75d. (3.5c.)	per car-mile
Year ending Sept. 30, 1910.....	.55d. (1.1c.)	per car-mile
Year ending Sept. 30, 1911.....	.88d. (1.76c.)	per car-mile
Year ending Sept. 30, 1912.....	.80d. (1.60c.)	per car-mile
Total in four years.....	3.98d. (8c.)	per car-mile

So profitable had the working of motor busses become in London at the beginning of the year 1912, and so serious a competitor had the road vehicles proved themselves to be in competition with all other forms of passenger conveyance, that Sir Edgar Speyer, Bart., decided to acquire the property of the London General and other omnibus companies, for the benefit of his electric-railway undertakings. The £100 shares of the company, which stood at only £18 in December, 1909, had risen steadily to £400 in June last, and the residue of the minority who opposed the purchase were, with the approval of the courts, bought out at £275 per £100 of stock a few months later.

The net profits at that date were certainly not less than 4d. (8c.) per mile run, and there are good reasons for stating that they are now not less than 5d. (10c.) per mile run.

Seeing that the costs for an electric tramcar, in London, inclusive of interest, depreciation, renewals, reserve, and all charges, reach the high figure of 11.2d. (22.4c.) per mile run, compared with 7.3d. (14.6c.) for the motor bus, the serious nature of the competition which has now to be faced by all electric-tramcar interests will be realized. In addition, the public has the fullest confidence that motor-bus services are now reliable and uniform. This has brought a very considerable access of new support.

LESS OBSTRUCTION THAN WITH TRAMCARS—The author desires to draw particular attention to the lower factor of obstructiveness which experience in London has shown to exist in favor of the motor bus, as compared with the electric tramcar. He wishes, further, to emphasize the fact that no other city in the world has had comparable opportunities for an official opinion of this kind to be formed. The official decision of the Traffic Branch of the Board of Trade, which Government Department was for some years specially engaged in making observations to enable it to come to a decision, is that the relative obstruction to traffic of the electric tramcar is 10, while that of the motor omnibus is only 3. The same department, in the course of its 1910 report, pointed out that, while electric traction is fully developed, improvements in motor busses must still take place.

For the foregoing reasons, among others, the motor bus has become very much more popular in London, with the commercial and general public, since the date of the Brussels Congress.

INCLUSIVE COSTS OF RUNNING—The author wishes to repeat that the saving on capital account, of any motor-bus system, with an electric-tramcar system, varied between 65% and 80% for the same capacity for traffic. There is no capital outlay upon track construction or overhead equipment, in the case of the motor-bus undertaking. He has brought up to date the figures of London, and these are given herewith.

WORKING EXPENDITURE (LONDON)

	Average of 1907 type motor busses in service during the year 1909	Average for petrol and petrol-electric motor busses during the year 1912
	Pence per bus-mile	
Traffic expenses	2.65	2.43
Running and maintenance	3.28	2.44
Tires	1.33	1.02
General expenses	0.79	0.62
Depreciation	1.00	0.50
Interest on capital	0.50	0.31
Totals	9.55	7.32

While London costs have gone down as shown above, costs in provincial centers remain in the neighborhood of 9d. (18c.) per bus-mile. This is due to the fact that road surfaces in the country are not so good as the paved surfaces of the cities. In addition, the same high daily mileage cannot usefully be covered in the country, and country services are frequently not able to average more than 70 miles a day, compared with 100 miles or more per day in London, per vehicle.

In the United Kingdom, apart from London, there are now upward of 4500 motor omnibuses and motor chars-a-bancs, and the average profit from working these varies from 3d. (6c.) to 1s. (24c.) per mile run.

An Electric Rail-Grinding Machine

A process for repairing worn track and special work (rails, frogs, etc.) by electric welding was described in ENGINEERING NEWS of Aug. 14, and reference was made to the use of a special grinding machine for surfacing the welded parts to a true level and finish.

This grinding machine is shown in the acompanying cuts, Fig. 1 being a general view and Fig. 2 a drawing

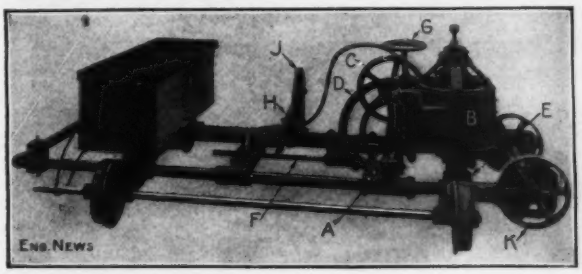


FIG. 1. GRINDING MACHINE FOR DRESSING RAILS, SPECIAL TRACK WORK AND WELDS IN TRACKS

showing the hollow or cupped grinding wheel, which is a special feature of the machine. The grinder is mounted on four flanged wheels which ride on the track rails, and on the frame is a sliding carriage *A*, to which is attached an electric motor *B*. The carriage can be shifted across the frame, and can be revolved in a vertical plane so as to have the motor shaft either vertical or horizontal. This is effected by the handwheel *C*, with worm-gear engaging with the toothed quadrant *D*.

The normal position of the motor is vertical, having the grinding wheel *E* mounted upon its shaft. The wheel is of carborundum and is hollow or cupped, as shown in Fig. 2. This form of wheel is a special feature of the machine, which is claimed to make it impossible for the grinding to cause corrugations or depressions in the surface of the rail, while it insures the grinding out of the smallest corrugations. The wheel is hooped with steel as a precaution against bursting. The motor can be set at a slight angle so as to grind the rail head on an incline if desired. For grinding the gage side of the rail head, a plain grinding wheel may be used, the sliding carriage being moved back by means of the horizontal screw *F*, and the motor lowered by the vertical screw and handwheel *G*, so as to put the wheel in proper position.

In working on the rails, the machine is moved forward and backward by means of the ratchet handle *H*; the spur wheel *J* of which gears through a small intermediate wheel to a pinion on one of the axles. For grinding in rail grooves, frog flangeways, etc., the motor is swung to a horizontal position, and the grinding wheel removed to allow of coupling to the motor shaft a flexible shaft operating an ordinary grinding wheel which is held by an operator. Track drills, reamers or other tools can be operated in the same way.

For any work except the surface grinding the machine may be removed from the track, so that the work will not interfere with traffic. To facilitate moving it on and off the rails, two small flat-tired wheels *K* are placed at one end of the frame, on a shaft at right angles to the carrying axles, and beyond the track. To move the machine, the opposite end of the frame is raised slightly so as to bring the flat wheels in contact with the paving, when the machine can be pushed around like a truck. The total weight is about 1000 lb. The machine can be

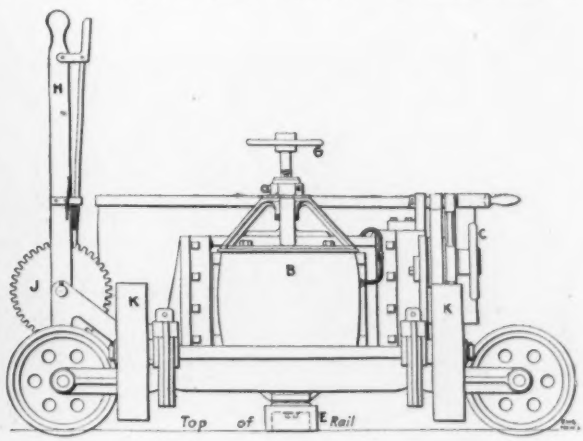


FIG. 2. TRACK-GRINDING MACHINE, SHOWING THE CUPPED GRINDING WHEEL

used for wet grinding, so as to do rapid work without fear of impairing the metal. Power is taken from the trolley wire by means of a pole with a flexible cable which is hooked over the wire.

This grinding machine is the invention of Mr. Venning, Construction Engineer of the Cincinnati Traction Co. It is manufactured and sold by the Indianapolis Switch & Frog Co., of Springfield, Ohio, and we are indebted to that company for drawings and other information.

Overcrowded Streets Cars are again receiving attention. In a bill prepared by Representative Norris (Nebraska) it is proposed that strap hangers in Washington, D. C., shall pay half fare, according to the New York "Press." This is on the assumption that as dividends are paid largely by the strap-hangers, the simplest way to provide sufficient seating capacity is to reduce the railway companies' revenue from this source. In a recent bulletin of the Health Department, of Louisville, Ky., the following statement appears:

A street car crowded to its greatest capacity, all the seats occupied, the aisles jammed with people clinging to straps, swaying against each other, many of them coughing and sneezing, is exceedingly dangerous to the public health. Under such conditions the air breathed is filthy and germ laden from diseased throats and lungs and head-colds in active stages. One or two small ventilators, even if always open, are not sufficient.

A Large Arch-Truss Drill-Hall

SYNOPSIS—In armory buildings the roof of the drill hall, covering a great expanse of open floor space, is the special engineering feature of the design. The accompanying article describes a drill hall of large size in which the roof is carried by a series of three-hinged arch trusses of novel design and construction.

The new armory now being built for the University of Illinois at Urbana, Ill., is made necessary by the growth of that institution and by the government requirements for military instruction to the students. The land grant made to the University by the U. S. Government in 1862 requires such instruction to be given to all students, but the old armory provides room for only 500, while the university regiment numbered 1525 last year. The new armory will have a hall 394x200 ft., in which the entire regiment can be drilled.

The building will be 420x276 ft., the side and end portions being of brick and terra cotta and extending to a height of about 40 ft. Each side portion, flanking the drill hall, will have company rooms at the ground level, bath and locker rooms on the second floor, and a rifle range on the top floor. Galleries on each side of the drill hall, and cantilevered over the main floor, will have seating capacity for some 3000 persons. Besides its military purpose, this building will serve for meetings of the student body, commencement exercises, conventions and other large gatherings. An appropriation of $100,000 was made by the Illinois legislature in 1911, and work is now well advanced on the drill hall. An additional appropriation will be required to complete the building, with all its facilities.

The architectural design and the general outline of the structural design were prepared by W. Carbys Zimmerman, of Chicago, then supervising architect for the state of Illinois. The structural design of the great drill hall was worked out by J. H. Heuser, consulting engineer, and was in direct charge of E. Gray, designing engineer; this steelwork was fabricated and erected by the Morava Construction Co. The engineers and contractors are all of Chicago, and to them we are indebted for plans and information.

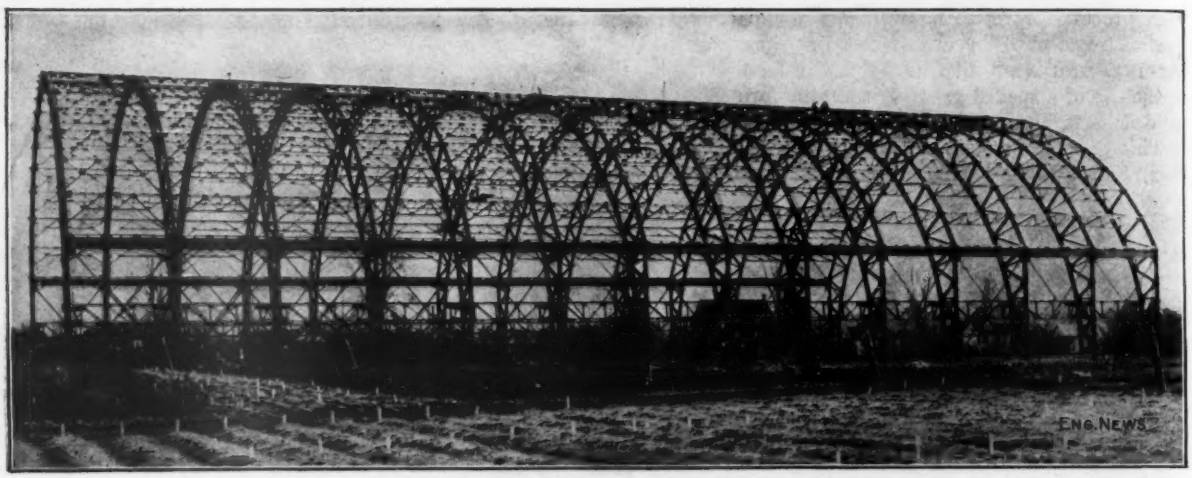


FIG. 1. ARCH FRAMEWORK OF DRILL HALL, UNIVERSITY OF ILLINOIS
(Span 206 ft., rise 94 ft. 3 in.)

DESIGN OF THE DRILL HALL

The specially interesting feature in the design of the drill hall is the use of three-hinged arch trusses, in which the chord and web members are of Bethlehem rolled H-shapes. By using these shapes the amount of riveting required was reduced to a minimum. The use of Bethlehem shapes for this purpose is an innovation in steel construction, and in view of this fact the engineers prepared a drawing of half of the truss complete to a scale of ½ in. to the foot, showing (to scale) the number and position of rivets required at each joint; this enabled the steel contractors to scale the size of gusset plates. The advantage of this was very evident when the bids were opened, as the estimated tonnages of three contractors varied by less than one ton on the entire work.

The drill-hall arches are shown in Fig. 2. An unusual feature in the web members is that the struts are all practically radial instead of being vertical, as in many trusses of this type. This arrangement was suggested by the architect as giving a more pleasing effect, while it also simplifies the structural details. The 4-in. top pin forms the sole connection at the top of the truss, so that the truss is a true three-hinged arch. It was originally planned in this way, but afterward it was proposed by the university officials to connect the chords by horizontal members above and below the pin. On further consideration, however, this plan was abandoned as being unnecessary.

The notable feature of the truss design, as noted above, is the use of H-beams and I-beams for all members, this construction enabling each member to be made of a single piece and eliminating all built-up members. This greatly simplified the detailing and construction work, and also reduced the amount of riveting to a minimum. As shown in Fig. 3, each chord is composed of 12-in. H-beams, varying in weight in the different panels. Each piece is cut to panel length, and the joint comprises two

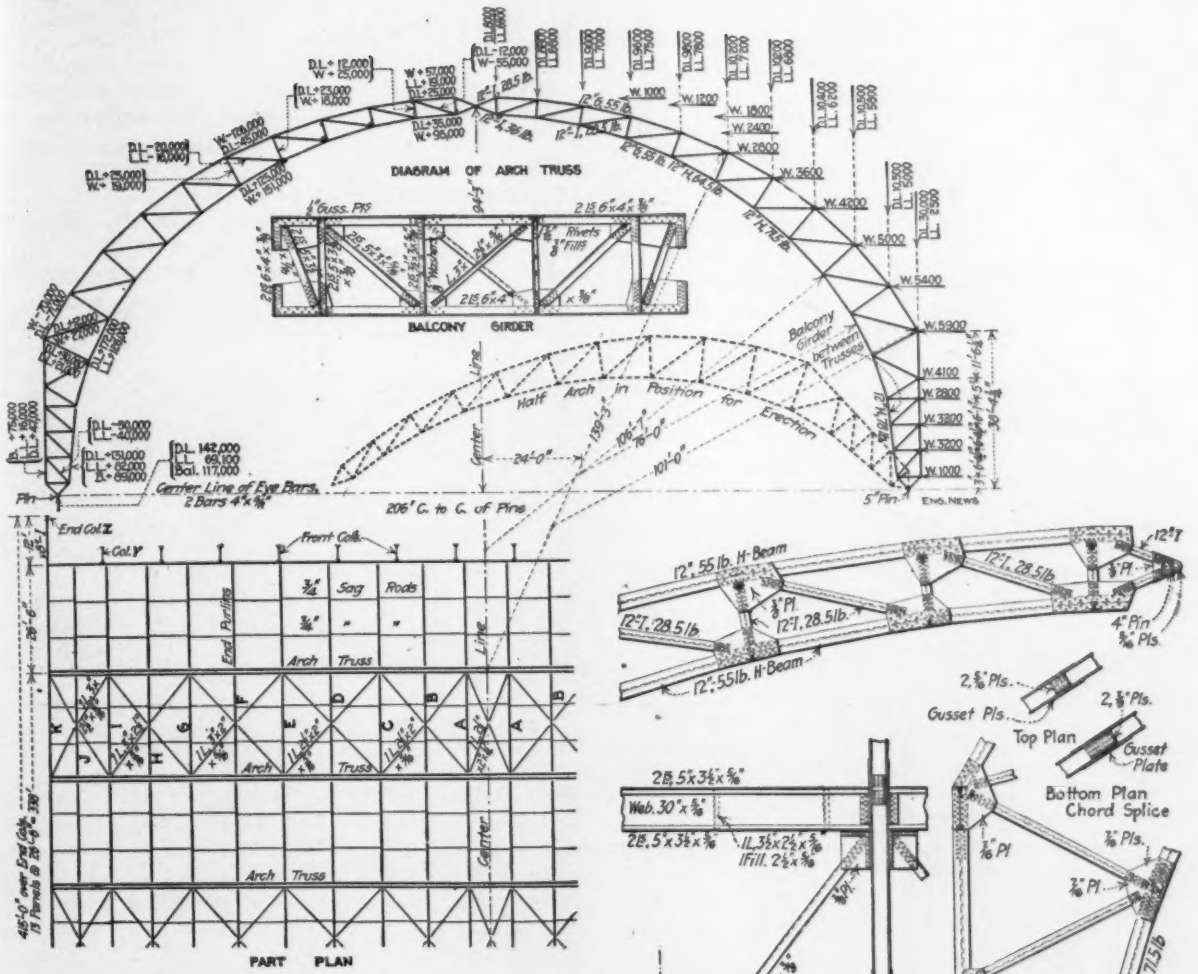


FIG. 2. THREE-HINGED ARCH-TRUSS CONSTRUCTION OF THE DRILL HALL FOR THE ARMORY AT THE UNIVERSITY OF ILLINOIS

(Each member of the truss is a single H-beam or I-beam, no built-up members being used.)

splice plates on the web and two side plates which serve as flange splices and also as gusset or connection plates for the attachment of the web members of the truss. Each web member is a 12-in. I-beam. At the bottom of the truss there is a pair of ½-in. plates across the chords, while the diagonals coming to a point at the crown are also fitted with similar but smaller pin plates.

The clear span is 206 ft. c. to c. of end pins, with a height of 94 ft. 3 in. from the end pins to the top pin. The radii are 76 ft. and 106 ft. 7 in. on the inner chord, and 101 ft. and 139 ft. 3 in. on the outer chord. The backs of the trusses are vertical to a height of about 38 ft. The 5-in. shoe pins of each truss are connected by a pair of ties composed of eye-bars 4x⅝ in. These ties are embedded in concrete in a trench beneath the floor. The assumed live-load is 25 lb. per sq.ft., and the wind load 20 and 15 lb. per sq.ft., respectively, for the sides and ends of the building. The stresses used in working out the design were as follows: tension, 18,000 lb. dead-load and 24,000 lb. combined load; compression, $18{,}000 - 80\,l \div r$. The weight of each arch truss complete is about 36 tons.

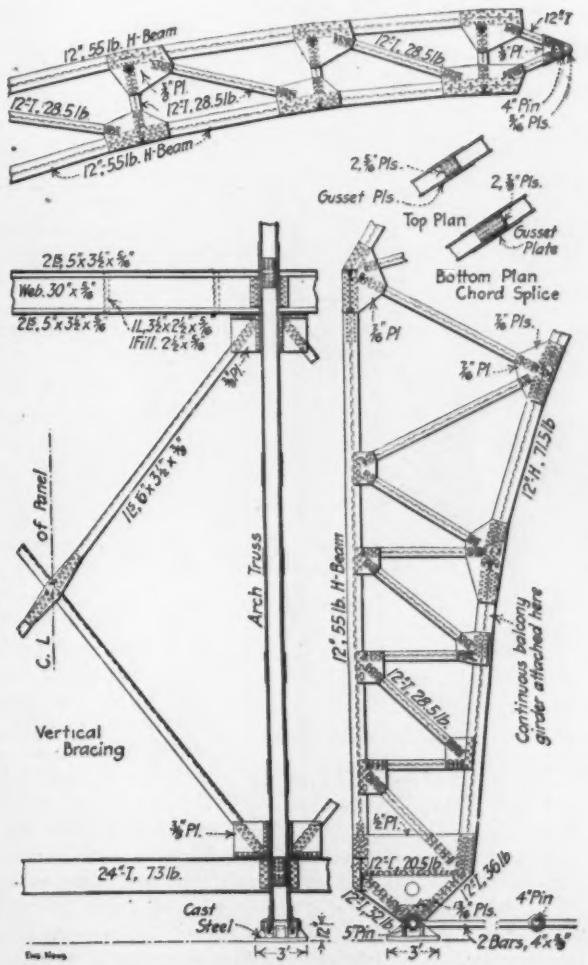


FIG. 3. DETAILS OF CONSTRUCTION OF THREE-HINGED ARCH TRUSSES

The arch trusses are spaced 26 ft. apart, and are connected by trussed purlins at every panel-point; the purlins are set in the planes of the web struts. Those near the crown are the full depth of the truss, while those in the deeper panels near the sides have long kneebrace connec-

tions to the lower chord. The roof framing above the purlins consists of 4x8-in. timbers, spaced 4 ft. c. to c., to carry the 1¼-in. sheathing, which will be covered with a felt and composition roofing. Ventilators and skylights will be provided in the panels between the arched trusses.

The arch trusses are connected longitudinally along the lower portion of the outer chords by a line of 24-in. I-beams at the bottom and 30-in. plate girders at the top of the vertical part of these chords. Along the inner chords they are connected by a line of 6-ft. trusses or balcony girders, just below the springing of the arched portion of the chord. These will form the support for the cantilever girders of the steel balcony framing, to be built later. The end pairs and alternate pairs of trusses are connected across the top chords by diagonal bracing of single angles. In the vertical portion of the outer chords, diagonal bracing is introduced in all panels, with the exception of the three middle panels on each side, where the main entrances will be located.

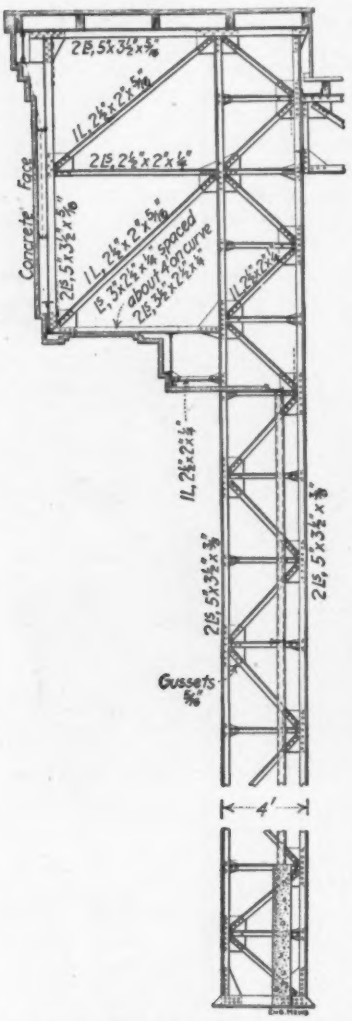


FIG. 4. END CONSTRUCTION OF DRILL HALL, UNIVERSITY OF ILLINOIS

The ends of the drill hall will be carried by columns which are vertical trusses about 4 ft. wide (longitudinally with the hall). They are of varying height, according to their position, and have their tops connected to the purlins of the roof arch. On the outer side they carry projecting frames with two lines of arched lattice girders to support the architectural work. Between the columns is a concrete wall extending to a height of about 7 ft., above which is a steel framing with wood sashes, practically the entire end of the building being of glass. This end construction is shown in Fig. 4, but is not yet built.

The soil is clay, giving a good foundation but little below the surface. The end shoes of the trusses rest on concrete footings, 4 ft. deep and 13½ ft. square at the base, which is 6 ft. 6 in. below grade. The bottom of the footing is reinforced by a network of two rows of 1-in. twisted bars, spaced 6 in. apart. The columns at the ends have similar footings 4x8 ft. and 3½x7 ft. at the base (3 ft. below grade).

ERECTION WORK

The erection of the trusses was accomplished in an unusual manner. Each truss was built and shipped

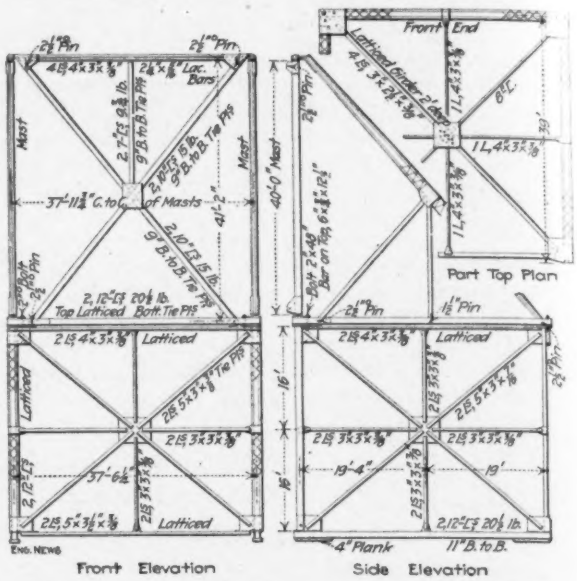


FIG. 5. TRAVELER USED IN THE ERECTION OF THE DRILL HALL

eight sections, and the four sections for each half of the arch were assembled and riveted up in horizontal position on the ground, close to their final positions. One side of the arch was then lifted into a vertical plane by a two-boom traveler, and its lower end was fitted to the shoe and the shoe pin driven. The truss was then lowered, revolving on this pin until its head rested on the ground, the truss being supported by guys at the sides. The

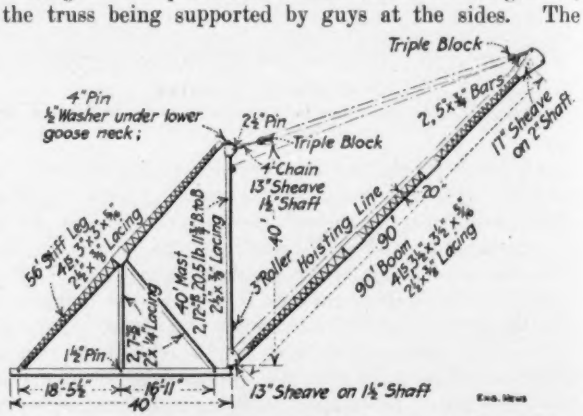


FIG. 6. STIFF-LEG DERRICK USED ON ERECTION TRAVELER

(There were two of these derricks on the front of the traveler.)

opposite half of the arch was then raised and adjusted in the same way. The traveler was then placed at the center of the arch, and the hoisting lines of the two booms were attached near the ends of the two half-arches, which were then raised, the lower ends rotating on the shoe pins. The arch was then held while the center pin was driven and the purlins were placed, connecting it to the

adjacent truss. When the half arches were swung from the horizontal to the vertical position they showed practically no weave or bending, owing to the stiffness of their construction.

The traveler, Fig. 5, consisted of a steel tower about 40 ft. square and 33 ft. high to the working deck. On this deck were two 40-ft. masts with A-frames, each carrying a 90-ft. boom, so that the top of the boom could reach about 20 ft. above the top of the arched trusses, the maximum height from the ground to the hoisting block being 125 ft. The traveler was supported on wood rollers on tracks of 16x16-in. timbers about 40 ft. apart. The upper part of the traveler was composed of two stiff-leg derricks of the type shown in Fig. 6, with one stiff-leg and one sill removed from each, the masts being stepped on the traveler frame and connected by bracing, as shown. Each derrick had a lifting capacity of 15 tons, and was operated by an engine of 8 hp., the two engines being placed on a platform on the lower sills of the traveler, about 2 ft. from the ground.

This traveler was used also in assembling material and building the trusses on the ground. The other equipment comprised a steam-operated air compressor, hand forges and pneumatic riveting hammers. Fig. 7 shows some of the stages of the erection work, and also the completed framing before the roof covering was placed.

A somewhat similar method of handling the trusses was employed in erecting the arch trusses of the 69th Regiment armory in New York City (ENGINEERING NEWS, June 1, 1905), except that for that building two 116-ft. erecting towers were used, with booms at different levels.

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A Locomotive Crane with an Electro-Magnet Lift, fitted with a small turbo-generator set to furnish electric current for the magnet, has recently been experimented with, by the Brown Hoisting Machinery Co., of Cleveland, Ohio. A 15-ton crane with a 40-ft. boom was fitted with a 5-kw. Terry turbo-generator set. By this means electric wiring, exterior to the locomotive, is eliminated. The turbo-generator set is independent of the other operating portions of the mechanism, which adhere to standard practice, and is mounted in a compartment beneath the floor where stands the operator.

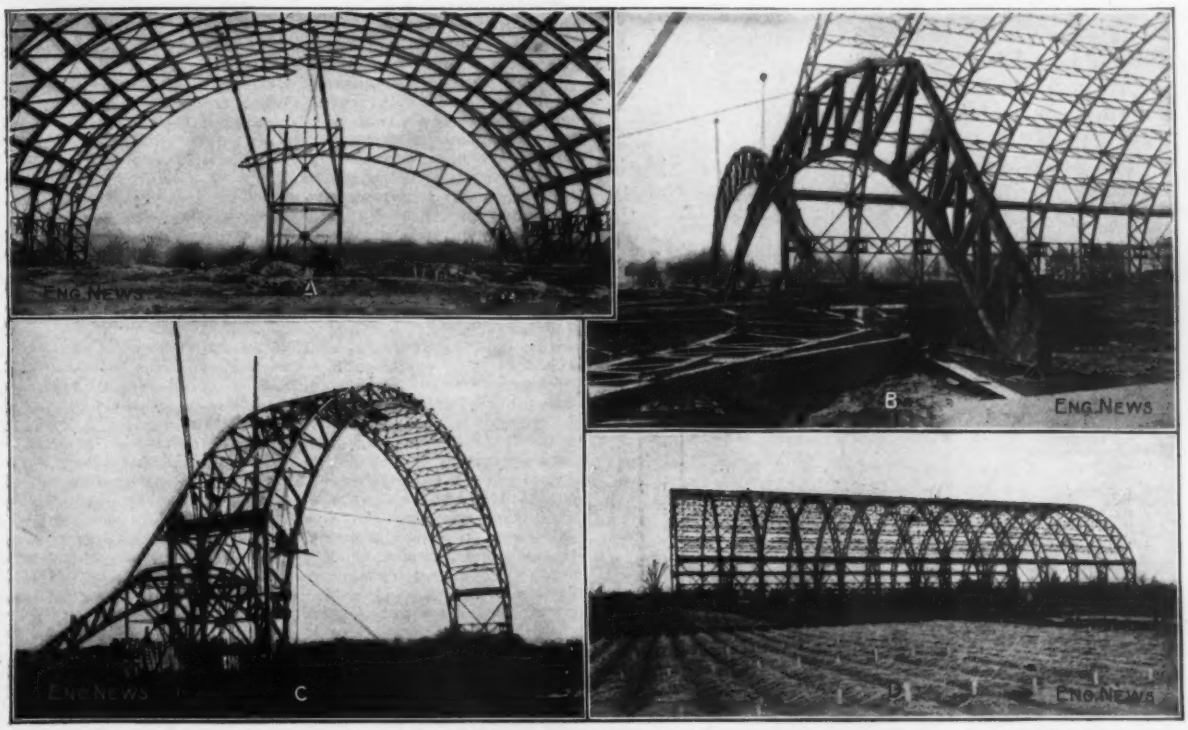


FIG. 7. ERECTION OF THE STEEL ARCH-TRUSS STRUCTURE OF THE DRILL HALL

A. Raising the second half of an arch truss, the first half (at the left) being in position. This shows the double-boom steel traveler, used throughout the work. The longitudinal lattice trusses, two panels above the ground, are to support the transverse cantilever trusses of the gallery.

B. Erecting one of the arch trusses. The half-arch one in front has the lower end fitted to its shoe and its upper end resting temporarily on the ground, and is held in position by guys. The one in the rear is being raised by the two booms of the traveler and is revolving on its shoe pin as the end is raised. At the left is another arch being assembled and riveted up in horizontal position.

C. The first pair of arch trusses erected, with purlins and lateral bracing in position. Another half arch is being handled. This view shows the great vertical reach of the booms on the traveler.

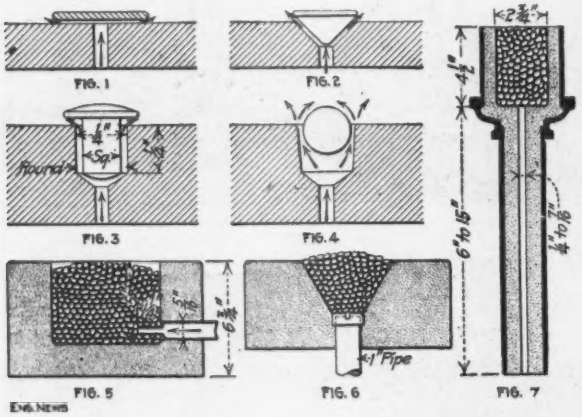
D. Completed framework of the drill hall, with arch trusses erected and braced. The size of the men of the riveting gang on top of the structure gives an idea of its great size.

A Benevolent Fund has been established by the Institution of Mechanical Engineers of Great Britain, its purpose being to give financial aid to prominent members of the Institute who may through no fault of their own become destitute. A public meeting was recently held to arouse interest in the project and some $20,000 has already been contributed toward the fund. The plan of operation is to keep the fund invested and use the income only for the relief of deserving cases. It will be manifest that in a Society numbering some 6000 members the income from a small fund will be sufficient to give substantial relief only in occasional isolated cases. It does at times happen, however, that engineers who have held high rank in the profession and to whom the profession as a whole may be largely indebted may in their declining years be placed in a position where the aid ordinarily afforded by friends and relatives in such cases is unavailable and the members of the profession itself ought to extend relief. If it shall provide for such cases, the Benevolent Fund will be a distinct credit to the profession.

The Development of Improved Gas-Heating Appliances

In ENGINEERING NEWS, Jan. 18, 1912, was shown the scheme of Prof. W. A. Bone, of Leeds University, Leeds, England, for improving gas-heating devices by localizing the combustion of a gas-air mixture at a porous diaphragm, or its equivalent, to secure benefit of an acceleration of the rate of combustion which would give large heating capacity to a small element. In ENGINEERING NEWS, Feb. 15, 1912, was noted the great similarity of these devices to certain inventions of C. E. Lucke, Professor of Mechanical Engineering at Columbia University, New York City. The latter emphasized in his early patents the localization of the combustion zone, using the products of combustion in well known ways, while the former emphasized the utility of intensified combustion and efficiency of radiation in transfer of heat energy.

It appears that the development of these allied schemes has been undertaken in this country by the Gas & Oil Combustion Co., under the engineering direction



of Dr. Lucke, and that a laboratory has been established in New York City for the commercial development of apparatus on these new lines. Many interesting problems have arisen and have been solved already; a few notes are appended on work described in much greater detail by Dr. Lucke in the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society (October, 1913).

LOCALIZATION OF COMBUSTION—The flame cap will be steady in location when the velocity of gas mixture approaching it is equal to the rate of flame propagation. Mechanical construction to permit passages of suitably changing area may be in endless variety, but certain precautions are needed: (1) The tendency for a gas jet from an orifice to resist sidewise expansion may prevent filling the passage unless forced to do so by baffles; (2) the tendency for free jets in a gaseous atmosphere is to entrain or diffuse at the edges, becoming so dilute as not to burn properly.

The simplest apparatus would perhaps be a narrow angle conical passage. In time such a tube would heat back, and heating of the flowing mixture would increase its velocity and push away the flame surface. But this would be more than counteracted by the increase of flame propagation rate due to the rise of mixture temperature and the accelerating effect of hot walls. In most cases if the rate of supply is varied much there is a blowoff or a flash back of the flame.

The simplest flame spreader is a plate over a hole (Fig. 1). This offers some operating difficulties as both plate and hearth get very hot and unequally so. An easier construction is a solid cone with small ribs placed in a counterbore of the feed hole (Fig. 2). Another has a mushroom baffle with a square stem fitting in a round enlargement of the feed hole (Fig. 3). (The dimensions shown gave good service with mixture pressures up to 3 in. of water.) The most permanent form of molded baffles is the refractory ball in a conical hole (Fig. 4).

All such constructions only approximate uniform incandescence. However, any sort of porous screen where in the path of the escaping gases will get uniformly hot and three types have been used; (1) a perforated plate of nonoxidizable alloy such as used in electric heaters, (2) a layer of granular refractory material, (3) a diaphragm of bonded granular material, the most satisfactory of which is alundum (artificial corundum or aluminum oxide).

In view of the importance of developing a maximum of heat energy in radiant form and considering that loose granules or a porous diaphragm may serve the double purpose of radiating screen and combustion localizer, everything else may be abandoned for these except perhaps in certain special cases. The work done has been largely concentrated on an effort to learn how these granular beds and bonded diaphragms should be handled to yield commercial apparatus; by reason of the simplicity of the loose bed it has been consistently favored over the bonded.

Any uniform grained bed will act as a substantially perfect spreader for mixture issuing from an orifice, but the quantitative effect of variations in size of grain, shape of bed, size and position of the orifice, etc., have all had to be determined by experiment.

One of the simplest arrangements is shown in Fig. 5, where a nozzle projects into a bed of broken firebrick. With coarse grains from ½ to ⅝ in., the mixture on ignition flashed instantly down through the bed, locating quite near the nozzle as shown later by the more or less spherical lump that fused there. The same action took place as the size of grain was reduced to from $^{3}/_{32}$ to $^{1}/_{8}$ in., when the mixture burned on top instead of flashing down through. In a few minutes the top layer became hot and then seemed to cool; on scraping away the top it was seen that the combustion surface had receded. The combustion zone finally located where it was in the coarser material. To show that the reduced total gas flow and total heat generation due to stoppage of the nozzle by fine grain was not responsible for the difference in flame action at the start, the same series of results were obtained in a pyramidal chamber (Fig. 6), where the nozzle was made by a pair of hacksaw cuts in the pipe cap, the flow being substantially the same for all different sizes of grain.

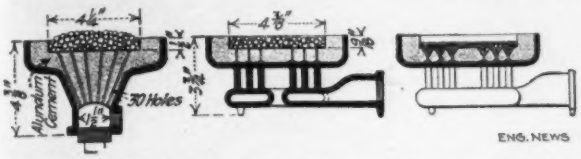
Once it was clear that size of grain made only a temporary difference in action, longer runs became desirable to find out the possible heating effect on the nozzles. Long runs with more refractory grain showed that some forms of feed orifices became heated so as to ignite the mixture in the feed pipe while some other forms permitted operation indefinitely.

At any time, increase in pressure of mixture supplied would have driven the combustion surface to a safe distance from the nozzle, but this was deemed an unwise expedient since (1) all domestic apparatus must operate on low pressure, and (2) all industrial apparatus at some time would be operated at part capacity, which is equivalent to low-pressure operation.

Frequently the best working nozzle was really hotter than one which flashed back quickly. It was clear that metal must be kept away from the feed orifice proper. It was found that all feed holes become incandescent at the fire end with low gas pressures, and that heat flowed back through the walls to heat the mixture passing through. The mixture passageway could be at any temperature without harm if of uniform bore and if when cold the flow velocity was great enough to prevent back flash. It was found that the length of uniform-bore feed pipe that would be cool enough at its supply end safely to be joined to a header or box, was greater for large than for small holes and that the allowable length was a definite number of diameters. For instance, with an apparatus shown in Fig. 7, a single refractory lined tube having a hole ¼ in. in diameter and 6 in. long could be operated indefinitely at 7 in. water pressure where as a hole of $^{7}/_{32}$ in. diameter, but of the same length, flashed back at 1.5 in. water pressure, and continued to do so even after the length had been increased to 15 in. Small-diameter orifices ($^{1}/_{8}$ in.), with about 1½-in. length, have been operated indefinitely on pressures as low as 0.2 in.

CONTROL OF INTENSITY OF COMBUSTION—The question of control of heat generated per square foot of firebed, seemed at first a more elusive matter than the prevention of back flash through nozzles. The two problems really are related, though the relation is not as clear as it might be. The first was at how high an intensity might gas be burned and how might the structure be formed to permit steady supply and combustion. The second problem was how such a burner might be turned down to a so called "simmering point" without giving trouble.

When the whole cross-section of firebed is taken up by the combustion zone, then gas mixture is being supplied as fast as it can be burned within the space available, and any increase in rate of supply will result in blowoff. It is necessary that, when everything is cold, the mixture be supplied at a lower rate and then after the bed is heated its accelerating effect on combustion may be used to localize a very much increased supply. As an illustration, the results of a single series of tests on the apparatus shown in Fig. 7 will serve. The pressures were never extended above 12 in. of water at



FIGS. 8, 9 AND 10. THREE FORMS OF DOMESTIC FLAMELESS GAS BURNERS

the point of mixture supply and began with a single $\frac{1}{4}$-in. hole, discharging into a cylinder 2¾ in. in diameter, area 6 sq.in. As increase of pressure, up to this maximum noted, failed to supply as much mixture as could be consumed in the available area, a second, a third and finally a fourth hole was added, even then not reaching the limit of consumption. With four holes and a pressure of 10½ in. of water the rate of combustion of 2460 cu.ft. per sq.ft. per hr. was reached; the gas had a calorific value of 600 B.t.u. per cu.ft., which showed 1,584,000 B.t.u. per hr. per sq.ft. of firebed. There was no indication that the limit had been reached, but the rate was so high as to give trouble with the available refractory material, and the series was not carried beyond. The conclusion is that higher rates of combustion than have been known are now easily obtainable, and rates higher than any common refractory can resist; hence, if any service arises that demands such rates of heating, the need can be met. Of the several refractories tried, the most satisfactory found was white alundum, with linings of alundum cement.

The most difficult problem was to find a suitable structure for permanent localization of the combustion surface with very low supply pressures with uniform incandescence at the surface. Long series of experiments showed the failure of the single point supply to distribute mixture so as not to flash back and yet uniformly to heat the top of the radiating bed under low rates of combustion. It was concluded that multiple-feed orifices must be used with a surface bed of sufficient thickness to localize the combustion and equalize the spotty appearance. Since it was shown that a single long feed hole could be proportioned permanently to resist backward heat flow it followed that several feed holes might be grouped so as to be fed from a common point, discharging mixture at the other end over as large an area as needed for any desired surface rate of combustion, but resisting flash back.

This was the basis of construction shown in Fig. 8. The holes were molded in alundum cement by wires held in place in the end radiating from a bottom chamber. The distance between feed chamber and hearth is long enough so that the dissipation of heat from the side walls will balance the heat carried down through the solid material. A reasonably practical burner for cook-stove service was evolved from this design, there being 34 $\frac{1}{4}$-in. holes spaced in three rings. On the hearth was a bed of white alundum $^{24}/_{60}$- to $^{30}/_{60}$-in. grain ½ in. thick. The dimensions were selected to give a consumption near that of standard top burners of ordinary gas cook stoves—15 cu.ft. per hr. under 2½-in. water pressure. The arrangement gave a uniform top heat and was operative at low pressure for an indefinite time.

To show the adaptability of this general type of construction other burners were built. One of these with a 6x10-in. hearth was intended for use below an assay muffle. To show how this could be extended to large areas without excessive length of holes in the solid group three wedge-shape sections, each 1x3 ft., were used to make a hearth of 9 sq.ft. This was tried out in the firebox of the Baldwin locomotive in the mechanical-engineering laboratory at Columbia University. Mixture was supplied through a 12-in. header to three 5-in. branches, one to each burner section. At 10 in. water pressure, the rate of combustion would be 20,000 cu.ft. of gas per hour—an intensity of 2230 cu.ft. (1,338,000 B.t.u.) per hr. per sq.ft. of firebed area.

The trouble of molding holes in the refractory material between hearth and feed box and the ease with which large sections may be broken led to a search for a better form. The holes through which the mixture is to be supplied have to be cooled, but so spaced to give proper distribution of heat. Forming the holes in independent tubes was logically a more effective scheme. This has been incorporated in burners which seem to be satisfactory commercial forms for all sorts of surface combustion apparatus. One such, designed as the top burner for a domestic cook stove, is shown in Fig. 9. The casting is drilled, wires are inserted in the drilled holes and the lining pressed into place around them. On removing the wires the cement forms a perfect hole for the hearth, exactly registering with the drilled hole in the casting. The burner shown has 35, $\frac{1}{8}$-in. holes, but other diameters have been used, and other material for beds of various thicknesses. The consumption and top temperature for each vary, and any result desired by the designer can be obtained by the proper selection of dimensions. The gas consumption for two such is shown in Fig. 10. Inverted burners with 60 $\frac{1}{8}$-in. holes in two rows and a long narrow hearth with loose granulated material held in place by wire mesh screens, have been used, giving a bright broiling heat with excellent service. The same screen construction has been used with a vertical curved-face room heater; a hearth 8½x5 in. supplied by 72 holes, gives as intense a radiation of heat as is safe. The same use of independently cooled feed holes with metal walls and registering orifices in refractory hearths has been applied to high-rate appliances such as muffles. The same castings can be used for a wide range of capacities by changing drill sizes. In special muffles easy control of temperature gradient through the furnace is secured irrespective of the flue by changing the quantity of mixture supplied to different points.

As shown in the foregoing, it is possible to make a surface-combustion burner for any desired intensity of combustion to operate for indefinite periods without disturbance or adjustment. But with commercial apparatus it must be possible to adjust the consumption of any burner from a minimum low to a maximum high rate and to operate safely and surely at any point.

Some classes of service require very prompt change in the radiating-bed temperature after adjustment, including a very quick initial heating after lighting cold; other classes of service require a slow change. Sluggishness is obtained with a thick bed of large heat-storage capacity; sensitiveness comes from the use of as light beds as possible. But too great reduction in thickness may leave the bed so thin that it is no longer effective in reducing mixture velocity at the orifices, and the mixture will blow off at various points where the grain does not properly baffle. The escape of this unburned mixture reduces the amount of heat developed, delays the heating and smells. Apparently reduction in size of grain corrects this, but limits to its use are met; the grain must not be so small as to fall into the end of the orifice; a thin layer of fine grain will not heat uniformly with hole spacing satisfactory for larger grain. The fine-grain bed heats from the surface inward while the coarser grain heats from the inside outward. With two such beds of equal weight of mate-

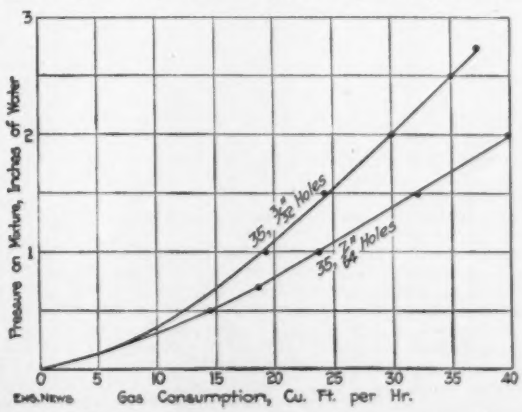


FIG. 11. PRESSURE-COMBUSTION CURVES FOR FLAMELESS GAS BURNER (FIG. 9)

rial the one that heats from the outside first will be quicker because of the nonescape of unburned mixture while heating.

This has led to a successful form of quick-heating top burner which becomes uniformly incandescent in about a half minute, compared with three or four minutes for the ordinary ½-in. thickness of large grain bed. This one is formed by counter-sinking the outlet side of the feed holes as shown in Fig. 11, filling the taper holes with $^{10}/_{60}$- to $^{3}/_{60}$-in. grain, and covering the hearth to a depth of ¼ in.

A quick-heating type of construction is that of the formed baffle over which is placed a radiant screen, of perforated or woven metal, a thin layer of loose grain, or a refractory diaphragm. A nickel-chromium-iron alloy has been most used as the screen over ball baffles (Fig. 2). This construction may be a direct competitor of the electric heater, using the same radiant material at the same temperature. These plates have a fair life if not operated at too high a temperature; a gas consumption of about 0.5 cu.ft. per hr. per sq.in. of radiation surface is a satisfactory rate and gives a good red heat. These are heated up in ten seconds. It is a serious question whether the reduction of heating time should be carried so far, even in domestic apparatus because of the corresponding small heat storage.

The application of the bonded diaphragm is a problem in itself, as the localization of combustion is not so readily controlled under wide ranges of mixture pressures. All such diaphragms, except those of great porosity and thickness, will heat from the outside inward. The combustion zone will finally locate between the hearth and the bottom face of the diaphragm. Up to the moment of ignition below the diaphragm, the outer surface has been hot and radiating, but now the heat will be practically all absorbed by the hearth and support until these become incandescent. During this

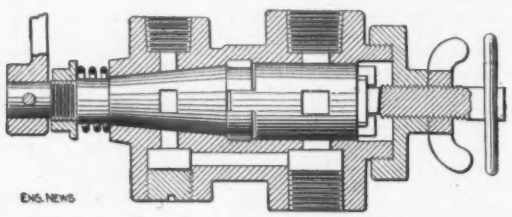


FIG. 12. SECTION OF DOUBLE-PORTED MIXING VALVE

period, the top radiating surface will cool, afterwards slowly recovering its temperature, when it will operate indefinitely without change. Many diaphragms of all sorts of grain materials and bonds have been tried and all abandoned in favor of alundum. The results of tests for one series of alundum diaphragms will illustrate the action. These were 5⅛ in. in diameter, $\frac{1}{16}$ in. thick, set in a hearth over 35 $\frac{1}{16}$ in. holes. The time of recovery of surface temperature varied considerably, but in the best the whole time was about five minutes; in some cases it reached 15 or 20 minutes.

AUXILIARY APPARATUS—Air under pressure is always necessary for the operation of these combustion appliances, but the pressure need be no greater than is easily obtainable with electrically driven fans. Where furnaces have skillful operators there need be no special appliance for proportioning air to gas in the mixture, or for changing the mixture pressure as service conditions require. Therefore, any of the standard fans and blowers may be used for compressing air alone or air and gas separately with a hand-adjusted cock in the air and gas pipes in pressure is ample. The more pressure there is the more definite the proportioning and the smaller the valve needed. To permit of adjustment to changes of quality in gas one port is made of fixed size with the other adjustable, though in opening and closing both vary in constant ratio. It is not expected that users will make this adjustment. Equalization of gas and air pressures has been accomplished with a damper valve (Fig. 13) in the main air passage, attached to a diaphragm regulator connected to the gas line.

About 1 in. water head is desirable on the air for good regulator action. With the full available gas pressure used, say, 3 in., the fan should deliver at 4 in., but with gas mixture pressures as low as 1½ in. satisfactory operation can be secured. This would require a gas pressure less than 2 in. and fan delivery at less than 3 in. The power required for such a fan is so small than any lamp socket would serve for any domestic appliance, even a large range. Where there were several appliances to be operated air might come from a single fan.

EFFICIENCY—It is found that the absolute and relative efficiency of surface combustion and Bunsen-burner appliances is not constant, but varies with local conditions. For this reason figures given are confined to domestic appliances operating on city gas, all made by removing Bunsen burners from standard appliances and substituting surface combustion types. Data from a large mass of tests conducted with various bed materials and thicknesses, different shapes, sizes and materials of vessels, different distances between bed or flame and the vessel, at all sort of gas or mixture pressures show such variations as to be perplexing at first to one seeking some definite general conclusions on the relative value of the two systems. Careful analysis, however, reveals some order under as nearly identical conditions as differences in the two systems permit. The surface-combustion burners always do an equal amount of heating of water with less gas than the Bunsen, but how much less seems to be dependent on the construction of burner, stove frame and water vessel. Perhaps the most important of these external conditions is the vessel itself. The best judgment that can now be made is that taking into consideration all probable conditions there may be expected an average consumption ratio of about 1.5 of Bunsen to flameless, which indicates a saving about 35% what is now being used.

The question naturally arises as to when the saving of gas becomes large enough to pay for the electric current

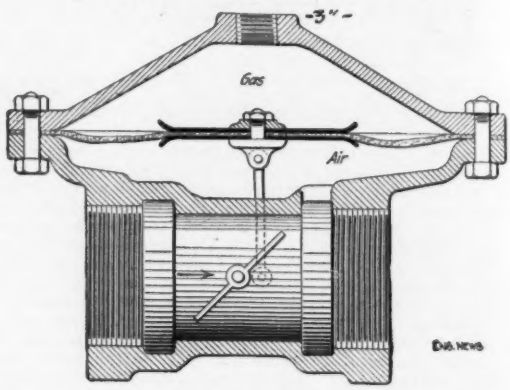


FIG. 13. SECTION OF AIR-PRESSURE REGULATOR

consumed by the fan and at what time the net saving will pay for the increased cost of surface-combustion appliances over Bunsen type. The last question is answered only when it is known how much the appliance will be used as the fixed charges per hour of use depend on the number of service hours per year. If it is to be used one week per year it matters little how efficient it may be and the cheapest thing available in first cost is the thing to buy. An appliance that is used every day, however, will pay for the extra cost and doubly so if operated many hours in the day on service requiring gas. All sort of hypothetical calculations may be made but one short way for disposing of the electrical cost is to consider that the gas saved by a single top burner (domestic range) will more than pay for the electric current to operate an entire range, so that for all burners in operation in excess of one, the electric current costs nothing.

Only results with New York city illuminating gas are here reported, though work with other fuels permits the statement that all gaseous or liquid fuels are equally available.

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A Cargo of Elephants—The London correspondent of the "Indian and Eastern Engineer" is responsible for the following story:

"Many years ago, at the time of the Arabic Pasha rebellion in Egypt, a cargo of elephants was shipped in the hold of a vessel. They were stalled athwartship—facing outwards. One dead calm day, on an oily sea, the good ship began to roll without any visible cause, and kept on rolling more and more till everyone thought she was going to turn turtle. On going down below, it was found that the elephants were amusing themselves by swinging the ship in unison—having nothing else to do. The rolling ceased when some food diverted their attention."

Dynamite for Subsoiling Agricultural Lands is being exploited by the E. I. Du Pont de Nemours Powder Co. It is claimed that on many soils the loosening up of the subsoil will improve the drainage and increase the fertility. The work is done by boring holes to a depth of about 3 ft., which on ordinary soil are spaced about 15 ft. apart each way. In each hole is placed about a quarter of a pound of low-grade 20% dynamite. The materials required for an acre of land treated in this way are about 50 lb. of dynamite, 194 blasting caps, and about 600 ft. of fuse. These materials are sold direct to consumers at a cost of about $12.50. To the cost of materials must be added, of courses, the cost of transportation and the labor of boring the holes and placing the dynamite.

The County Surveyor-Engineer*

By J. W. Mavity†

Of the 105 counties of the state of Kansas, I have received definite information from 54. Of the 54 counties 50 have suffered from poorly made surveys and insufficient records, sometimes no records at all, caused by incompetent men who filled the office of County Surveyor. Only four of these counties have been fortunate enough to have qualified men fill the office continuously, or, if unfortunate enough to elect a man not qualified, have elected one who used the good judgment of not making any surveys himself.

Fifty-two of the 54 county surveyors heard from are strongly in favor of raising the standard of County Surveyor and County Engineer by requiring a certain amount of practical experience, or a diploma from some good engineering school, or, if the applicant possesses neither of these, he should pass an examination. I might add that a number of Surveyors heard from could not meet any of the above requirements, but nevertheless are in favor of requiring such a qualification. Only two of the 54 heard from were opposed to requiring a qualification, and one of them believes that a man should be qualified, but thinks that the people are beginning to realize the necessity of it and, therefore, legislation along that line is not needed.

Now what about the 51 counties from which I received no reply? It is safe to assume that conditions are equally as bad, and I believe a great deal worse as to the qualifications of the men filling the office in these counties, for the 54 counties heard from include practically all the Engineers who are in anywise prominent in engineering in the state.

It would not be so bad if the poor conditions existing in the past were all we had to contend with, but the trouble is that the people continue to elect, in many instances, just as incompetent men as ever filled the office in the past. A considerable number of counties recently elected men to the office who know absolutely nothing about surveying. While there are more competent men filling the offices of County Surveyor and County Engineer at the present than in the past, yet the data that I have secured tends to show that the people are not very wide awake as to the necessity of filling these offices with qualified men.

It seems almost incredulous that some of the men who are filling these offices, are absolutely ignorant of the first principles of surveying. The following extract from a report made by a County Surveyor will give some idea of the kind of a survey this class of men make. "True line commencing at the southeast corner of section thence north (Var. 10° 15′ E) 2642 ft. found ¼ section rock down and set it. Thence on same line 2642 ft., and found northeast corner rock standing 4 ft. too far north. Moved it and reset it 4 ft. south. Thence west (Var. 10° 45′ E) 2642 ft. to ¼ section rock found rock standing. Thence on same line 2642 ft. to northwest corner found rock standing but 14 ft. too far south, removed rock and reset rock 14 ft. north on point where my survey and measurements came to."

This rock that was removed and reset 14 ft. north was a government corner. This County Surveyor was evidently blissfully ignorant of the fact that the original survey must govern, because the land was bought in reference to it. You can best judge for yourself the mischief done by allowing such men to practice surveying. I could give you many other instances in land and city surveys, also of County Engineers' bridge and road plans and specifications, which show that they know absolutely nothing of the work they are trying to do.

It is quite evident that some qualifications should be required before a person can be a candidate for the office of County Surveyor. To be able to read and write and know the multiplication tables is not sufficient preparation to fit a man for the duties of this office. He should be an engineer, a practical engineer, qualified to do any kind of engineering work which might confront him. The majority of competent men filling the office of County Surveyor and County Engineer, at present are men who are fitted to do, and who are doing a general engineering business.

A large per cent. of the counties of our state have enough general engineering to keep a competent man busy all of the time, and many of them enough work to keep several busy all of the time. If a competent man is filling either of these positions a great deal more engineering work is done in such a county than in a county that has no such competent man, and much work will be given such an engineer, where otherwise they would try to get along without engineering service.

I find a considerable amount of dissatisfaction among the County Engineers of the state relative to the State Agricultural College furnishing free plans for bridge and road work. It is claimed that the qualified engineer is thus deprived of the work which rightly belongs to him, and for which he is in a better position to work up the most economical design, because of his being on the ground all the time and familiar with the local conditions and what is best suited for that particular locality. Does it seem right that one of our educational institutions which is preparing men each year to handle these engineering problems, should step in and do the work that should be done by some of these students when competent?

The whole law regarding the County Surveyor and County Engineer should be repealed, and a new law adequate to the needs of today should be passed.

The offices of County Surveyor and County Engineer should be combined, making one office known as the County Surveyor or Engineer. I believe some provision should be made, whereby an engineer having four years' practical experience in the design and construction of works of a similar character as that required of such County Surveyor or Engineer, or a graduation from some engineering school with one year's practical experience in the designing and construction of such work, should be granted a certificate without being required to take an examination. All other applicants should be required to pass such examination as a competent nonpolitical examining board should deem sufficient to test his fitness for the position. No person except one holding a certificate should be eligible to the office.

The County Surveyor or Engineer should have charge of all surveys, and all road and bridge work in the County. He should locate and supervise the grading of all roads. The ordinary township officer of County Commissioner is not competent to inspect or judge in the acceptance of bridge work. All such important work should be in the hands of the Engineer. He should have a seal and the power to acknowledge any instrument. The office should then be put on a salary basis, and the cost of surveys be thus equalized, so that the man living 15 or 20 miles from the County seat need not pay a great deal more for his work than the man living close to the county seat has to pay for the same work.

The County Surveyor has supported the office of County Surveyor long enough, and the salary should now be made sufficient so that the office will support him. When we consider the insufficient salary paid the County Surveyor and County Engineer, it is not to be wondered at that so many incompetent men are filling these positions. At present, in order for a competent man to fill either of these positions, he must have a general engineering practice in connection therewith. He should also be given such assistants as officeman, rodman and tapeman, as the work of the county demands. At present the law allows the magnificent sum of $1.50 per day for rodman and tapeman. Just think of it, not as much as the common laborer in the ditch receives. It is almost impossible to get a man for this price and when you can find him, he is incompetent for such work. Suppose the surveyor takes competent help with him, there is transportation and hotel bills, that $1.50 a day will not begin to cover, to say nothing for wages. And the surveyor getting but $4 per day and his transportation has but a very meager wage after hotel accommodations are paid. No other class of equal ability works for less than 50% higher wages than the County Surveyor and County Engineer is getting.

In the extreme West where there is not enough work in each county for such an Engineer, some provision should be made whereby an Engineer could have charge of two counties.

The law should provide a more severe punishment for destroying corner stones. The road officials, at the present time, are responsible for the destruction of the greater part of such stones, and they are the very men who should help preserve them.

Compulsory evidence of a man who has knowledge of the location of certain monuments should be required. At the present, many men having such knowledge will not give such information at the time of the survey.

In conclusion I will say that the people are beginning to realize the necessity of reform along some of the lines mentioned. These problems should be given the careful attention of our Kansas Engineering Society to insure that the profession may not be hurt by unwise legislation, and we should lend our aid to dignify these offices until competent men will want them, and they will be filled by reputable Engineers. I, therefore, recommend that our Society get behind this proposition and work for a repeal of the present law concerning the County Surveyor and County Engineer, and secure the passage of such a law as will be a credit to the Engineers, and to the State of Kansas.

*Abstract of a paper read before the Kansas Engineering Society, Transactions of the Society for 1913, p. 69.

†Civil Engineer, Lyndon, Kan.

New Subway Construction in Boston, Mass.

Although at least five of the large cities of the United States are engaged in the study of subway systems for rapid transit, only Boston and New York are actively pursuing construction. The New York work has been noted from time to time in these columns; it is by far the largest enterprise of the sort ever undertaken. The new construction at Boston, while not so extensive, is nevertheless of sizable enough proportion to make it worthy of interest, particularly in view of the current agitation for subways in so many large cities, and the comparative scarcity of precedents in subway layout and design.

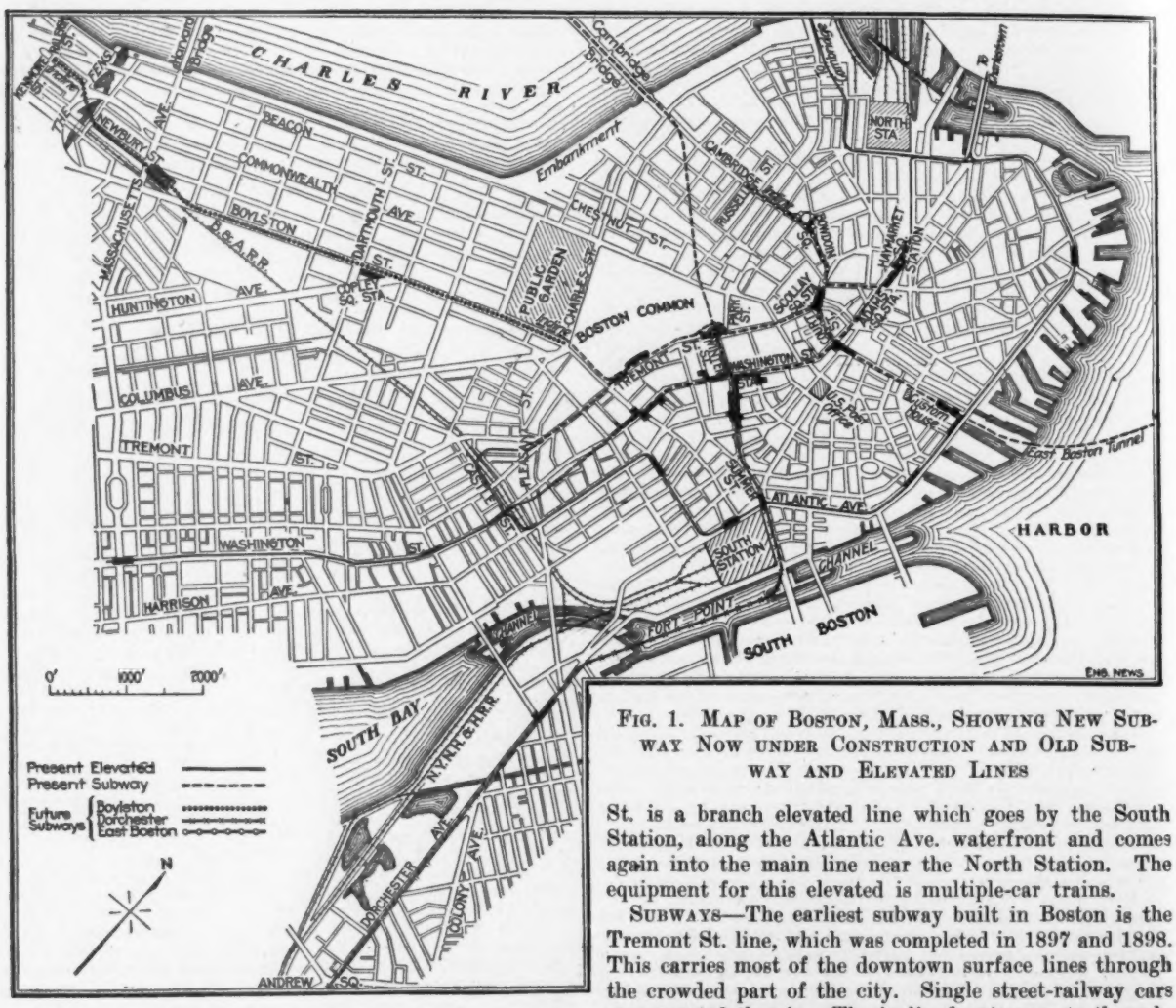

FIG. 1. MAP OF BOSTON, MASS., SHOWING NEW SUBWAY NOW UNDER CONSTRUCTION AND OLD SUBWAY AND ELEVATED LINES

PRESENT RAPID TRANSIT SYSTEM

The transit facilities of Boston are peculiar in that the street railways, the subways and the elevated lines are all owned or leased by the same company, the Boston Elevated Ry. Co. In the Tremont St. Subway, so called, in the East Boston Tunnel, on the short elevated line from the North Station to East Cambridge and on all surface lines, only single street-railway cars are operated; while in the Cambridge Subway, Washington St. Tunnel and on all the elevated system except as noted above, only multiple-unit trains are run. For some years, trains and cars have been in operation on various elevated and subway structures, all of which are shown on the accompanying map (Fig. 1), the surface lines being for the most part omitted from that map.

ELEVATED LINES—The main elevated line is shown approaching the city from the southwest, running along Washington St. to Castle St., thence it passes through the Washington St. Tunnel and emerges by an incline near the North Station to an elevated again, which runs to a terminal in Sullivan Sq., Charlestown. At Castle St. is a branch elevated line which goes by the South Station, along the Atlantic Ave. waterfront and comes again into the main line near the North Station. The equipment for this elevated is multiple-car trains.

SUBWAYS—The earliest subway built in Boston is the Tremont St. line, which was completed in 1897 and 1898. This carries most of the downtown surface lines through the crowded part of the city. Single street-railway cars are operated therein. The inclined entrances to the subway are at the Public Garden, at Pleasant St. and at the North Station. From the Public Garden incline the subway route is down Boylston St. to the corner of Tremont, where it turns, goes up Tremont St. to Park St. where the cars loop and return. The cars entering at Pleasant St. also go to Park St. and further, emerging at the incline at the North Station either to the surface or to the elevated structure running across the Charles River to East Cambridge.

The East Boston tunnel, opened Dec. 30, 1904,* has

*Described in "Engineering News" in a number of articles 1902-04.

no track connection with the Tremont St. Subway. It carries a street-car line easterly from Scollay Square to the Atlantic Ave. waterside district, thence under the harbor to an incline to the surface in East Boston.

The Washington St. Tunnel was opened Nov. 30, 1908, and is operated with multiple-car trains.

The Cambridge Subway, opened Mar. 23, 1912, runs from Harvard Square in Cambridge, across the Cambridge Bridge over the Charles River, into subway again in Boston, reaching eventually the terminus Park St., where the station is immediately under the Park St. station of the Tremont St. subway. This Cambridge subway is operated with multiple-car trains.

New Subways

The city is now engaged in the construction of three new subways, one of which, the Boylston St. subway, is an entirely new line, the other two being extensions of existing lines—one of the Cambridge subway and the other of the East Boston tunnel. Work is in progress upon all three lines, but no precise prediction can be made of the time of opening. It is expected, however, that the Boylston St. Subway will be opened for traffic in the summer of 1914. The total cost of construction of these new lines is estimated at $15,000,000.

Boylston Street Subway—For some years a project has been in view to provide more rapid transit through the Back Bay district, lying west of the Public Garden and north of the Boston & Albany R.R. A plan was adopted about three years ago for the so called Riverbank subway. This was to carry surface cars in a subway from the Fens near the Harvard Bridge, along the bank of the Charles River to just north of the Public Garden. where the line ran along Chestnut St. to the Park St. station. In 1911, however, this project was abandoned for the Boylston St. Subway, now under construction.

This two-track line, to carry surface cars in subway, runs from an incline in Commonwealth Ave. Parkway just east of Kenmore St. by a curved line under streets and private property to Boylston St. near Hereford St., along Boylston St., thence it connects with the Tremont St. Subway near Charles St. In the original design the Boylston St. Subway was to run down Boylston St. to the corner of Tremont, and thence to Park St. However, within the past year, the original design has been revised to the extent that the Boylston St. Subway will now make a temporary track connection with the Tremont St. Subway as before stated. The incline in the Public Garden is being changed from its present location southerly to the middle of Boylston St., and the street widened 40 ft. to provide traffic room, and the old incline is to be filled in. Further studies are being made in regard to the advisability of building the Boylston St. Subway to some point near Post Office Square instead of to Park St.

The subway has two types of cross-sections, the main difference being that one has an intermediate or center wall and the other has not. The section shown in Fig. 2 is typical of the center-wall construction and is at the westerly end of the line. It is, as shown, a reinforced-concrete section, resting, where required, upon piles, and where the earth has sufficient bearing power, the subway is placed directly upon it. The ground on which the subway is built varies from gravel and sand to a rather weak silt, and the differences in foundation design are on this account. The section for the easterly half of the line is about the same as that shown in Fig. 2 except that steel posts are placed along the center, instead of a continuous concrete wall.

The construction of this subway is practically complete with the exception of work on the two stations, one at Massachusetts Ave. and the other at Copley Sq., and also the incline at the Public Garden and the temporary connection with the old subway at Charles St., work on all of which is now in progress. The construction is being carried out by the cut-and-cover method throughout. First a trench is excavated on either side of the street and the sidewalls placed. Between the sidewalls, excavation is made from the surface for sufficient depth and the roof placed. The core is then removed and the invert built. A timber cover which carries the street traffic is carried across the full width of the subway location while construction work is going on below.

At the Copley Square station, where the foundations of the Old South Church are so near to the subway excavation as to require extraordinary care, a different procedure has been carried on. The foundations of the

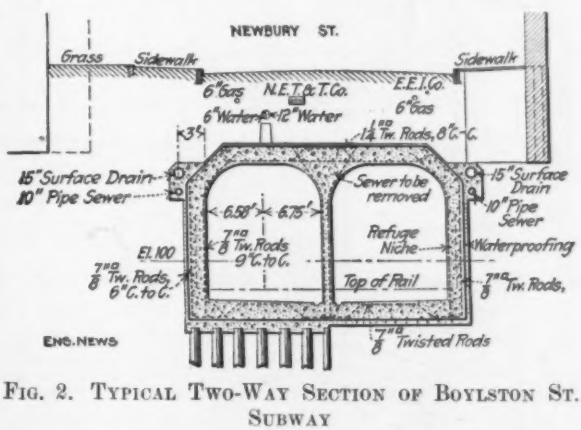

Fig. 2. Typical Two-Way Section of Boylston St. Subway

Old South Church were so near to the subway excavation as to endanger the permanence of the tower to the church, in fact that tower has leaned for many years, or since its completion. At this location the subway was constructed for its entire width in 12-ft. longitudinal sections, one entire section being completed before the next was started.

At this point and also opposite the Hotel Somerset in Newbury St., where the bottom of the subway excavation is below the bottom of the wooden piles of the building and close to them, interlocking steel sheet piling was driven on the outside lines of the subway excavation, before excavation below the foundations of the buildings was begun. This interlocking steel sheet piling was left in place. Its purpose was to prevent any movement of the adjacent earth which might tend to settle the buildings. Pockets of gravel in the silt and outside of the steel piling were filled with grout forced in under high pressure.

The subway is waterproofed by surrounding the entire structure with two or more layers of prepared fabric, each layer being mopped with a hot liquid asphalt.

In building the concrete section of the subway, expansion joints are placed about every 40 ft. to take care of contraction and expansion. At these joints strips of lead 10 in. wide and about ⅛ in. thick are placed in the concrete as the work is built up, so that 5 in. of the

width of the lead extends into the concrete on each side of the joints. This allows movement and at the same time helps to keep the subway water-tight.

As will be noted from the section in Fig. 2 the sewers and other conduits are carried alongside of the subway in openings which are a part of the subway structure. At Dartmouth St. a special siphon crossing (Fig. 3) under the subway is included in the section.

EAST BOSTON TUNNEL EXTENSION—The Boston end of the present East Boston tunnel is at Court and Tremont Sts. At this point a switchback transfers cars back to the tunnel under the harbor. The extension under construction will require lowering the part of the existing tunnel between Washington St. and Scollay Sq., continuing it under the present Scollay Sq. Station of the Tremont St. Subway, along Court St. and Cambridge St., coming to the surface at an incline on Cambridge St. near North Russell St. This is a street-car tunnel and will allow a track connection between the Cambridge St. surface cars running along Cambridge St., through the tunnel, to East Boston. In addition to the incline, a loop is to be built at Bowdoin Square, so that some of the cars may loop and go back through the tunnel to East Boston. Of this line, which is about 2300 ft. long, about one-half is now under construction. The section including the loop, and the middle section including the change in grade of old tunnel between Scollay Sq. and Washington St. have yet to be done. The work under Scollay Sq. is now under construction on a cost plus 10% basis.

DORCHESTER TUNNEL—This tunnel is to be a two-track structure for multiple-car subway trains, to extend the Cambridge subway at Tremont and Winter Sts. to South Boston and Dorchester, thus completing a through line from Harvard Sq., Cambridge, to Andrew Sq., in South Boston. The route is from the Park St. station of the subway, along Winter and Summer Sts. by the South Station, where it curves to the south and runs under the Fort Point Channel to Dorchester Ave. at about West Second St., and continues along Dorchester Ave. to the terminus at Andrew Sq. in South Boston.

Of this line the easterly end is now under construction, and plans are under way for that part which extends from the Summer Station to the station at Dewey Sq., in front of the South Railway Station. The portion between the Park St. Station and the Summer Station is completed. It will be necessary to build the part of the tunnel under the Fort Point Channel by the shield method, but the portions which are already under construction or completed are of the regular cut-and-cover type.

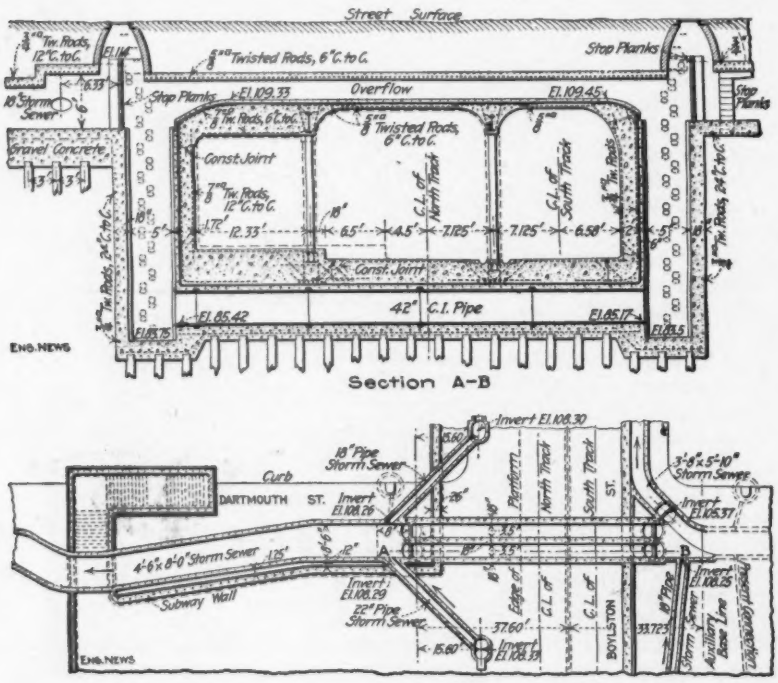

FIG. 3. SEWER CROSSING UNDER DARTMOUTH ST. STATION, BOYLSTON ST. SUBWAY, BOSTON, MASS.

ADMINISTRATION

The subways and tunnels of the City of Boston are under the control of the Boston Transit Commission during construction and until use begins. The commission is composed of members appointed by the Governor of the State of Massachusetts and the Mayor of the City of Boston, and has entire charge of the construction of the subways and tunnels. The money for the construction of the subway is procured by bond issues, authorized by the State Legislature of Massachusetts, but vouched for by the City of Boston. For the construction of the work noted in this article the city is authorized to issue bonds bearing interest up to 4% for a term not exceeding 40 years. The subways and tunnels are leased to the Boston Elevated Railway Company before construction is begun, and by recent legislation the leases are so arranged as to expire simultaneously in 1936, at which time they may be renewed by agreement between the city and the lessee corporation, which is in all cases the Boston Elevated Railway Company. This company pays to the city an annual rental varying from 4½% to 4⅞% of the net cost of the subway construction, and at the same time it installs and maintains all of the tracks and equipment.

A New French Naval Laboratory will be opened at Savran-livry, France, for special study and control of the explosives used in the navy, with a view of preventing such accidents as the recent explosions on the battleships "Iéna" and "Liberté," according to Pierre Baudin, Minister of Marine. The laboratory building and equipment is estimated to cost $120,000, and will be directed by M. Darzens, Professor of Chemistry at the Polytechnic, Paris, who will have under him naval officers and artillery engineers. A sample will be kept of each lot of powder placed on shipboard. These samples will be put under conditions of temperature and moisture more extreme than normally met in the service. M. Baudin states that the two principal causes of deterioration in powders are heat and moisture. At the first sign of change or decomposition of the sample, which is under constant observation, the laboratory will notify the proper authorities and the lot, of which the sample was a part, will be destroyed.

Water-Works Improvements at Ironwood, Mich.

By C. A. Alderman*

The Ironwood Water-Works Co., which is owned by the Ironwood & Bessemer Ry. & Light Co., supplies Ironwood, Mich., and Hurley, Wis., with water for fire and domestic purposes. Ironwood is the headquarters and distributing point for the Gogebic iron-mining range, and there are about 20,000 people served in the two cities with their suburbs and several mining localities.

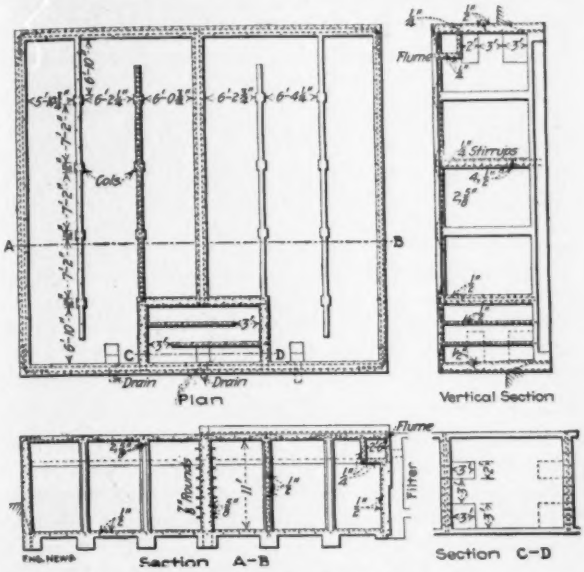

Fig. 1. Water-Works Settling Basin at Ironwood, Mich.

General Description—The water-works plant was built about 24 years ago, water being taken from the Montreal River, one mile above the city, by an intake at a low timber dam. Water is conducted north along the east side of the river for 2550 ft. through an 18-in. spirally-wound wood pipe to the pump house, which is on the bank of the river. Water was formerly taken from the river at the pump house, but owing to contamination at this point by a small creek containing sewage from one of the mining localities, it was necessary to locate the intake farther upstream.

The water is pumped through a 12-in. main to a steel standpipe 30 ft. in diameter and 50 ft. high, on Norrie Hill, giving a pressure of about 90 lb. Another standpipe of the same size is maintained in Hurley. The distributing mains consist of about 18 miles of 4- to 12-in. cast-iron pipe.

During the past year an electrically driven booster pump was installed on an 8-in. main supplying water to Jessieville, a suburb of Ironwood. This pump is cut into the main at a point part way up the hill where the pressure is reduced to 36 lb. per sq.in. The booster raises the pressure at this point to 100 lb., thus affording ample protection against fire for this part of the range.

Pumping was done by steam three years ago, since which time it has been done partially by steam and partially by electricity. During the past year steam has been abandoned entirely, the company having put into operation another hydro-electric plant, which gives it an abundant supply of current.

Water Treatment—The Montreal River water is very highly colored, due to the large amount of moss, leaves and vegetation on the head waters, the territory being practically an unbroken forest. The water is very soft and therefore not easily decolorized by ordinary processes. Up to about six years ago no attempt was made to treat the water. For the past six years the company has had in operation some small gravel filters or strainers which have simply removed any fish, sticks and leaves.

In the fall of 1912, two 50,000-gal. coagulating and settling basins were built, the old gravel strainers were converted into rapid sand filters and a third filter was added. A hypochlorite plant was installed.

Figs. 1 and 2 show the basins and the coagulant mixing tanks. Fig. 3 shows the new filters and Fig. 4 shows the hypochlorite apparatus. The filters were furnished by the Pittsburg Filter Mfg. Co., and the coagulating tanks and hypochlorite plant by the New York Continental Jewell Filtration Co.

Since the settling basins hold a total of only 100,000 gal., and 1,500,000 are pumped daily, the period of detention is less than two hours. It is proposed to bring the holding capacity up to 350,000 gal. in 1914. With this enlarged capacity it is hoped that 80 to 90% of the precipitate or flock will be retained in the basins, leaving only 10 to 20% to be removed by the filters.

Each of the three filters is 12x18 ft. in plan, giving a total area of 504 sq.ft. The filtering material, from the bottom upward, consists of 7 in. of ¾-in. to 1¾-in.

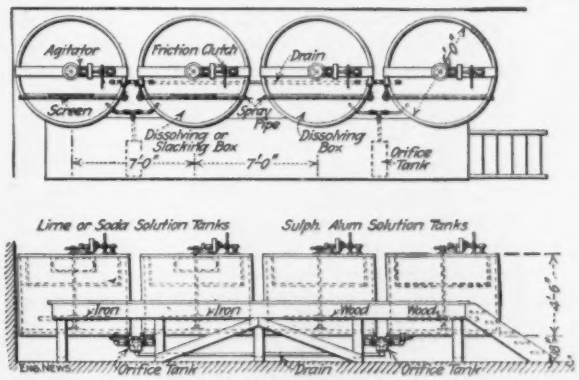

Fig. 2. Apparatus for Mixing and Feeding Coagulant, Ironwood, Mich.

gravel, 3 in. of ⅜- to ¾-in. gravel, 2 in. of ⅜- to 2-mm. gravel, making 12 in. of gravel, and 26 in. of 0.3 to 0.6 mm. Lake Superior sand. The original uniformity coefficient of the sand ranged as high as 6 in some of the batches, but this was gradually reduced in washing the sand after it was placed in the filters. Repeated washing brought the finer particles of sand to the surface, from which it was shoveled off. A 15-hp. electrically driven blower was installed to agitate the sand during washing.

The filters have to be washed five times in 24 hours at present, using nearly 10% of wash water. With all three filters in operation the rate of filtration to supply 1,500,000 gal. a day is about 2 gal. per sq.ft. per min.,

*Chief Engineer, Ironwood-Bessemer Railway & Light Co., Ironwood, Mich.

or about 100,000,000 gal. per day, which is in accordance with good practice. A fourth filter will be added so as to permit throwing one out of service for washing.

The cost of operating the coagulating basins and filters, exclusive of capital changes, is about $14 per day, or about $9.30 per 1,000,000 gal. This is with about 4½ grains per gal. of sulphate of alumina as a coagulant.

As a safeguard against contamination of the supply from the increasing population on the drainage area of

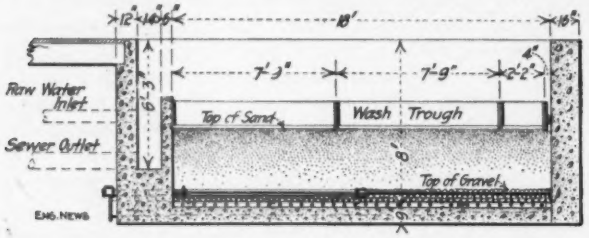

FIG. 3. RECONSTRUCTED FILTER FOR THE WATER-WORKS AT IRONWOOD, MICH.

(There are two wash troughs, 6 ft. c. to c., and 3 ft. from center to side wall.)

the source of supply the company installed a hypochlorite plant in 1912. This feeds into the settling basins but is used only when bacterial tests of the filtered water show that disinfection is needed.

DECOLORIZATION EXPERIMENTS—Various decolorizing agents have been tried experimentally but thus far sulphate of alumina has given the most satisfactory results. One treatment given to the raw water was as follows: 3 grains of calcium oxide per gal. and 3 grains of sulphate of iron were added; this was then electrolized for five minutes and at the end of three hours the color was reduced to 100 parts per million with no caustic alkalinity contained in the water, 220 parts per million being its normal state before treatment. The results of the

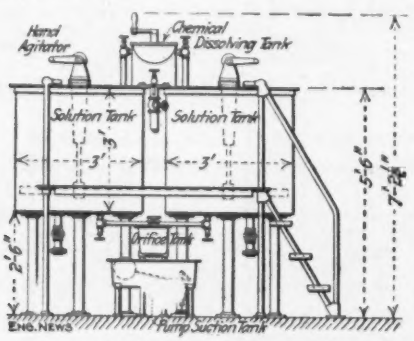

FIG. 4. HYPOCHLORITE MIXING AND FEEDING APPARATUS, IRONWOOD, MICH.

experiments made with sulphate of iron and calcium oxide led the chemists to believe that the color could not be removed with these chemicals unless a considerable amount of electrical current be added to the water afterwards and they expressed doubt as to this being commercially practicable.

Previous to the experiments, alumina and soda had been used as the coagulant. Sulphate of alumina in quantities of 1 to 10 grains per gal. was used experimentally, both alone and with hydrated lime and soda. The conclusion arrived at was that the best coagulant for this water is sulphate of alumina without either lime or soda, and in quantities of 3½ to 5 grains per gal. The amount varies according to the stage of the river, slightly more alum being required at flood stages than at low stages. The addition of soda or lime in small quantities (2 grains to 8 grains per gal.) slightly increased rather than decreased the color.

NOTES FROM THE ENGINEERING SCHOOLS

THE UNIVERSITY OF ILLINOIS—A two weeks' course in highway engineering is to be offered by the Civil Engineering Department, from Jan. 19 to 31, 1914. This is a result of the law enacted by the last Illinois legislature, regarding roads and bridges, which introduced new principles and methods concerning their construction and maintenance, created the office of county superintendent of highways, and provided for the possible appointment of township or district superintendents of highways. In view of this, the above course is offered, free of charge, to anyone aspiring to be appointed as a county or township superintendent of highways, or who is interested otherwise in the maintenance or construction of roads.

KANSAS STATE AGRICULTURAL COLLEGE—At the celebration of the 50th anniversary of the founding of the college, Oct. 28 to 30, student parades were a prominent feature. Notable among them was an evening affair by students of the Engineering Division. This composed, for the most part, electrically lighted floats drawn by gasoline and steam traction engines. Current used for lighting the floats was generated by small generating units mounted on the vehicles. The several floats were designed and built by students in the various courses and were representative of work of the respective branches.

The Highway Engineer of the Department of College Extension, Prof. W. S. Gearhart, has been instructed to prepare a correspondence course in road building for state road overseers. The college has a number of correspondence courses similarly developed under the extension department as need has been found. If sufficient interest results from the correspondence study of road work, a short course of instruction at the college will be arranged, similar to the special short courses which have been established, particularly in agricultural subjects.

A Visible Scale for Torsion Power Meters as used on propeller shafts of steamships is described by Dr. K. Suyehiro, of the Tokyo Imperial University in a recent paper before the Japanese Society of Naval Architects, abstracted in "Engineering," Oct. 3, 1913. In such a torsion meter, the turning moment is measured by measuring the twist of a certain length of the shaft. A sleve attached to the shaft at the one measuring point bears a radial arm or a disk, at whose outer edge is a circumferential scale facing inward, a mark opposite the zero point. Halfway between this scale and the center of the shaft is attached a mirror, facing outward, so as to reflect an image of the scale in a nearly radial direction outward. Just beside it is another mirror, attached to the sleeve projecting from the other measuring point of the shaft. These two mirrors reflect images of the scale and of the zero-point mark outward; the geometrical relations of scale and mirrors are such that the images of the scale seen in a viewing telescope appear to be stationary at the center of the shaft. While the image is visible for only a short part of the revolution of the shaft, there will be a sufficiently rapid succession of images to enable the scale to be read.

EDITORIALS

The construction of sewage-collecting systems rather than the building of sewage-treatment works in the cities and towns of North Carolina has been encouraged for some time past by the Board of Health of that State. This is commendable, when local conditions warrant it, and is in striking contrast with the practice of some other boards which in their zeal for sewage treatment discourage sewer extensions by refusing permission to make them unless treatment works are built or at least planned. Obviously, the North Carolina policy is better adapted to a sparsely settled than to a thickly settled state, and is all the more desirable because of the great need of sewage-collecting systems in Southern cities.

High Railway Speeds and Wheel Failures

Elsewhere in this issue we publish a brief summary of the Interstate Commerce Commission's investigation of a derailment which occurred last January at Stockwell, Ind., on the Big Four R.R. The derailment was caused by a broken tire on a car wheel. Mr. J. E. Howard, of the Bureau of Standards, who examined the broken tire, expresses the opinion that the breakage was due to thermal cracks which had formed in the tread.

The temperature attained by a railway wheel subjected to brake action depends on three factors: First, the pressure with which the brake is applied; second, the speed with which the wheel is turning, and, third, the time during which the brake application lasts. The maximum heating effect on the wheel, therefore, will be produced when the train is running at highest speed, when the brakes are applied with maximum pressure, and when the application is continued for the longest time. The first two of these elements will reach a maximum, it is evident, in the case of high-speed trains. Take the not infrequent case of a train running from 75 to 80 miles an hour upon which the brakes are suddenly applied. The energy stored in the moving train varies as the square of its speed; so the energy to be turned into heat at the brakeshoes will be nearly twice as great at 80 miles an hour as at 60 miles an hour. Thus, when the brakes are applied the train will run a distance of 1500 ft. or more before the speed will be reduced to 50 miles an hour, or an average speed of above 60 miles an hour and with the brakeshoes pressing against the wheel with full force.

This means that in a very few seconds over half the energy in the moving train will be converted into heat at the point of contact between the brakeshoe and the wheel. So rapidly is the heat generated that the surface of the tread becomes very much hotter than the metal an inch or two below. The consequence is that very heavy thermal stresses are set up in the wheel.

The metal of the tire is subject to a constant heavy tension on account of the shrinkage stress, which holds it on the center. Under these circumstances the unequal expansion of the inner and outer fibers of the tire throws the entire shrinkage stress on the inner layers.

Of course, the facts above decided are well known to railway mechanical engineers, but they ought to be better appreciated by all railway officers as they constitute a further sound reason why excessively high speeds in railway service involve elements of danger that do not exist with trains run at moderate speeds.

A Code of Ethics for the Engineering Profession

The code of professional ethics drafted a year ago by a committee of the American Society of Mechanical Engineers has now been formally approved by that Society by a letter-ballot vote. The code was first presented in a report of the committee which drafted the code, made to the annual meeting of the Society held in New York one year ago. It was at that meeting voted that the report should be published in the Society's *Proceedings*, with a request for discussion and criticism. The committee again reported in May recommending a few minor changes in the code as the result of the criticisms received.

In view of the importance of the matter to the profession, it was deemed to be unwise to make the final adoption of the committee's report dependent on the vote of the small percentage of the membership who might be present at a Society meeting. The committee, therefore, recommended that the code as finally amended be sent out to the entire membership accompanied by a letter ballot, on which each member could indicate his approval of the code as a whole, or could make exceptions to any paragraph thereof, or vote against it in its entirety. The meeting at Baltimore ordered that such action be taken, and the letter ballot was sent out in October.

The result of the ballot was reported at the annual business meeting held in New York last week. Thirteen hundred ballots were cast in favor of the adoption of the code as a whole; some 30 ballots excepted one paragraph or another of the code, and only two or three out of the entire membership voted against the code as a whole. The committee which drafted the code, made up of Messrs. Charles Whiting Baker, Chairman, Col. E. D. Meier, Chas. T. Main, Spencer Miller and Prof. C. R. Richards, is to be continued as a special committee on the interpretation of the code and its further amendment and revision as experience may indicate to be advisable. Substantially the committee is a committee of arbitration to which any two members of the Society who disagree as to the interpretation of the code or as to the proper rules and conduct which should govern them in their professional relations to each other may submit their differences for decision.

It may be of interest to note that among the letters received with the ballots on the code was one from Sir Douglas Fox, the eminent English engineer, who is an honorary member of the Society. In expressing his hearty approval of the code as drafted, Sir Douglas stated that "the code closely corresponds with the standards which govern professional practice in England."

A Neglected Opportunity of the Engineering Graduate

It seems surprising in this day of wholesale technical education, when thousands of young engineering graduates seeking employment are being turned out yearly, that there should be an apparently well founded complaint of the ignorance of the average County Engineer, even on such simple and fundamental subjects as the practice of surveying. It is doubtless both possible and desirable to remedy such a defect by legislation requiring certain qualifications of the applicant. Nevertheless, the existing conditions show that here is an important public office going begging, which might easily provide the means of developing a wider knowledge of engineering and greater executive ability than a large majority of the openings offered to young engineers.

The scope of the work of a county engineer in the wealthy agricultural regions of the Middle West is often as broad as that of the city engineer in a small Eastern city; and to a really capable young man the position offers an excellent opportunity to gain experience and acquaintance upon which to build an extensive private practice as well as to gain the satisfaction of having faithfully and efficiently served the public in a relatively important capacity.

At present the construction work planned and supervised by some of the county engineers in the Middle Western States is a travesty on engineering. Readers of ENGINEERING NEWS will perhaps recall various "county engineer bridge designs" which have been illustrated in our columns from time to time. This condition of affairs is not exaggerated. Elsewhere in this issue is a short abstract of a paper read before the Kansas Engineering Society, by J. W. Mavity, a civil engineer of Lyndon, Kan., which gives the results of a personal investigation of the holders of the office of County Engineer and County Surveyor in the State of Kansas.

There has been no change of conditions in Kansas since this paper was prepared. Under date of Nov. 18, Mr. Mavity writes to us as follows:

> I have known many instances of where farmers, blacksmiths and country school teachers have been elected to the office of County Surveyor, men knowing nothing whatever of engineering or surveying. I cannot say that I favor a law licensing the engineering profession as a whole, but I do favor a law imposing a qualification on a man seeking the office of County Surveyor, which is elective, and that of County Engineer, which is appointive, and providing a sufficient salary for these offices so that they will be sought by competent engineers.

In other states there has been a gradual awakening to the need of competent men to supervise highway work, which is, of course, an important part of the County Engineer's practice. Iowa, Illinois, Minnesota, Arkansas and other states have recently enacted laws strengthening their highway-engineering departments. In Iowa all roads, improved and otherwise, are under the jurisdiction of the State Highway Commission, which supervises the work of all the county engineers.* In the great majority of states, however, the jurisdiction of the State Highway Engineering Department does not extend beyond certain main roads improved or to be improved by state aid.

Whether there is a centralized state authority or not, there is much public work to be done in the smaller political units of a state, which for the sake of efficiency alone should be under the constant supervision of competent engineers.

Here, then, is an opportunity for the young engineer to acquire extensive engineering experience, self-reliance, executive ability, tact, business training and popularity—in fact, all the things but wealth which young engineers desire. It is true that the low salaries do not make the office attractive; perhaps, however, in many cases the low salaries are but the direct result of the character of the men who have hitherto held the office. The farmers may not be clever enough to differentiate between an engineer and one who calls himself an engineer, but it is a dollar to a doughnut that they are shrewd enough not to pay more for a county engineer's services than the quality of his work justifies. Let the office be freed of its political drawbacks and made attractive to young technical men, and the salaries will be much more likely to adjust themselves to the dignity and importance of the office.

Moreover, as Mr. Mavity has pointed out, there is an excellent opportunity for a capable and enterprising County Engineer to build up a private practice, and the more so as the advantages of water-supply, sanitation, irrigation and water power in the rural districts and on the large farms come to be more appreciated. Low as the present salary of a county engineer is, it is not so very much lower, taking into account the lower cost of living in the rural districts, than the salaries of many engineering for positions which young graduates eagerly seek. Certainly the experience to be gained by a County Engineer, provided he has a good grounding in fundamentals and a fund of common sense, is of great value to one who aspires to be a real civil engineer.

That an office of similar character and scope, even with low salaries and in the most remote localities, is attractive to the right kind of engineers, if the value of the experience to be gained is appreciated, is evidenced by the engineering personnel of the Department of Public Works of the Philippine Islands, the work of which was quite fully described in our issue of Nov. 13, by E. J. Westerhouse, Chief Division Engineer. If the experience to be gained and the joy of accomplishing things in engineering construction will attract bright young American engineers to the Philippine Islands at salaries of $1500 to $2000 a year, why should not similar experience to be gained in their own country be just as attractive and lead to the construction of public works which a more civilized and enlightened community will surely the more appreciate?

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Long-Term Guarantees on State Highway Contracts in New York

According to a published announcement on Nov. 24, the contentions between rival asphalt interests over New York State highway work are to be solved by admitting all asphalt to the state on an equal basis and requiring the contractors for road work to guarantee the road for a five-year period. Adoption of this plan is credited to Governor Glynn, who is quoted as follows in announcing it:

> After consultation with Commissioner Carlisle, the Attorney General and Commissioner of Efficiency and Economy Delaney, it has been decided from now on to throw the roads

*"Engineering News," July, 1913, p 131.

of New York State open to the asphalt markets of the world. It has been decided to have the specifications so drawn that every suitable asphalt known can be used, but to insert the conditions that every contractor must guarantee the road he builds for at least three and possibly five years. This will do away with the asphalt scandal. This provision will give every asphalt dealer in the world who has an asphalt which he will guarantee for five years an equal chance with every other asphalt man for the business of New York State.

It will also be notice to the contractors that they must get an asphalt whose makers are willing to give a five-year guarantee for the contractors' security.

The specifications also will require every contractor in connection with the presentation of any estimate for payment of state moneys to make a solemn affidavit as to the work performed, showing that it has been performed in exact accordance with the specifications so as to subject him to such penalty as may be involved in case he makes a false affidavit.

I have also directed that hereafter no one shall be employed upon the roads except for special competency and ability, and I positively will prevent the use of the highway department for political patronage purposes. Hereafter inspectors in the highway department will be employed for their ability to inspect roads, not for their ability to deliver votes or retain for the administration the friendship of political leaders.

One can easily appreciate the motives which actuated Governor Glynn in promulgating this policy. To a layman it seems impossible to sift the claims of the rival asphalt interests and coal-tar interests and the charges and countercharges of dishonesty, collusion and graft, which have been so freely circulated. All these bituminous materials for road treatment look pretty much alike to the observer and there is apparently little reason why one should be any better or more durable than another. It doubtless seems, therefore, like plain business common sense to say, let the contractor use any asphalt he pleases and guarantee its service.

We believe, however, that we express the opinion of the great majority of engineers thoroughly experienced in street and road work when we say that this policy which appears so sensible to the layman is so only in appearance; and that in the long run it will be a very expensive policy for the taxpayers of the state.

Governor Glynn says that the contractor will be required to guarantee the road he builds for three to five years. What will that guarantee cover, and how will it be decided whether the guarantee is fulfilled? Is it intended that the contractor shall bear the expense of maintaining the roads from the time of their completion till the end of the guarantee period? That would mean that the contractor must maintain an organization to take care of the repairs for a three- to five-year period, perhaps on a small stretch of work where the cost of such an independent organization would be very heavy. Or the state may take charge of the maintenance and charge the cost to the contractor, in which case the contractor will have to run the risk that the work of maintenance will be done in the expensive manner that has characterized so much of New York road work in the past.

This policy means, moreover, that the contractor's bond and liability will have to extend throughout the period of the guarantee; and the bonding companies will be required to be paid, and well paid, for doing this. The charges of the bonding companies are already a very heavy burden upon the contractor; and there is some reason to believe that the graft and corruption and heinous ways credited to the asphalt concerns could be fully duplicated if the secrets in connection with the business of the contractors' bonding companies were laid bare.

As we have often pointed out in the columns of ENGINEERING NEWS, the attempt so often made by well meaning public officials to load all sorts of burdens upon the contractor, always results in the end in the transfer of these burdens to the taxpayers. If the contractor on State highway work has got to wait from three to five years before receiving final payment for his job, and if he has got to spend money to maintain the roads during that time and pay heavy tributes to a bonding company for the whole period of the guarantee, there is no doubt whatever that all these items will be added to his bid price on the contract.

The thing which is so often overlooked by honest public officers, and even by many engineers, is that it is just as much for the public interest to so frame specifications and contracts as to secure a low bid for the work as it is to frame them so that the work shall be done in a thorough and permanent manner. We have long opposed, as contrary to the public interest, the practice of requiring long-term guarantees on street paving; but while such guarantees are unwise there, in the opinion of nearly all engineers, they are far more unwise on highway work, and especially on highways of the class in which some form of bituminous binder is used.

The fallacy which really lies at the bottom of such guarantees is that the road surfacing which is put down is a "permanent" surface. To demonstrate this fallacy it is only necessary to ride over any stretch of bituminous roadway which has been laid five years or more and has been subjected to fairly heavy traffic. Take a stretch of fifty miles of such roadway for example, wherever it can be found, that has been in service five years, and suppose that it had been originally laid under a five-year guarantee. How much of such roadway would today be accepted as complying with the guarantee, so that it could be finally accepted at the present time?

We are assuming, of course, that the guarantee will require that the road shall be, over its entire width, in good, serviceable condition, free from ruts and hollows and with no defects in the surface requiring repair, or which will call for resurfacing in the near future.

This would be a very moderate guarantee. The tendency of those who frame such guarantees is generally to specify that the road shall be substantially as good at the end of the guarantee period as when brand new. If any such guarantee were framed, however, it is entirely obvious that the road could never be accepted. Even the advocates of the various types of bituminous highway construction seldom claim for them a life under heavy traffic longer than eight to twelve years. At the end of a five-year period from construction, therefore, the road will be substantially half worn out; and a road that is half worn out cannot by any possibility be good as new, any more than could a suit of clothes.

Even should a guarantee be framed to read that the road should be no more than half worn out at the end of the five-year guarantee, it would be a matter of the greatest difficulty for any engineer to examine such a road and give a verdict that would be fair both to the contractor and to the State.

There is another aspect of the proposed guarantee that is eminently unfair and unwise. When carefully analyzed, the proposition in substance is that the State shall transfer to the contractor the burden of judging as to whether an asphalt or a tar is good or bad. The State is to say to the contractor "buy any old asphalt you please

at any old price, only see to it that it shall give such good service that at the end of three or five years the road you build shall fulfill the guarantee."

But if the State Highway Department, with a staff of competent engineers at its disposal, cannot tell in advance whether an asphalt is good or bad, how does it expect the contractor to determine this? He has no laboratory to make systematic tests upon the materials which he uses; and it is no more properly a part of his business to decide what materials shall be used to give a permanent and satisfactory construction than it is his business to write the specifications for the work. All the road dopes look alike to him; and if the state attempts the unwise policy of thus unloading the burden of their selection upon him, we believe that in nine cases out of ten he will simply select the cheapest and trust to luck that it will come out all right in the end.

One can, however, appreciate fully the difficult situation in which Governor Glynn and Commissioner Carlisle find themselves. The policy or practice of accepting certain trade brands and refusing others in any public work is certain to lead to all sorts of charges of graft, favoritism and corruption. The only possible way we know of to avoid this difficulty is to draft specifications which will describe just the qualities which a material must have in order to be acceptable. Such specifications are, in fact, in common use by engineers engaged in highway construction. They are not perfect, of course. It is useless to search for perfection in road specifications or anywhere else. Such specifications do, however, represent the accumulated knowledge and experience of the best engineers as to what is required for durability and good service in bituminous materials for highway construction.

It is entirely possible, moreover, to secure engineers of high professional character, and above any possible suspicion of corrupting influence, who could draft such specifications for the New York Highway Department in the regular course of business. We know, in fact, of no other possible method by which the State highway work of New York can be carried on and good work can be obtained at reasonable cost.

LETTERS TO THE EDITOR

Cableway for Unloading Cars

Sir—In your issue of Nov. 20 in the description of the cableway for unloading concrete material from cars into a storage hopper, appears the following: "In perfecting the design of the plant Mr. Louer was assisted by Mr. Page, of the Page Engineering Co. (which supplied the bucket and made the drawings for the steel towers)."

The fact is that early in the past summer, this company prepared a drawing and a working model of the plant described and interested the track-elevation department of the C., R. I. & P. R.R., in Chicago, with a view to trying the outfit. The drawing and model were shown to the engineer of this department, and while being considered by him, Mr. Louer came to us and said he had heard we had a machine for unloading concrete from cars, and that he had a customer he thought would be interested in such a plant.

The drawing and model were shown and explained to him, and later he brought Mr. Middleton, engineer of track elevation of the C., M. & St. P. R.R. Our company then prepared a general drawing showing this method, and after several conferences with Mr. Middleton we were asked for a proposition to furnish a machine according to our drawing. As Mr. Louer had interested the customer, and at that time was furnishing mixing machinery for this same work, we made our proposition to the W. B. Louer Co. to furnish the two steel towers erected on the railway company's cars, and a special Page bucket, cableway carriage and the necessary bolts and sheaves.

This proposition was accepted, the W. B. Louer Co. furnishing the hoisting engine, gasoline engine and cables, as per specifications prepared by the Page Engineering Co. Patents covering this device have been applied for by the writer and are now pending.

PAGE ENGINEERING CO.
Jno. W. Page, President.

1002 Security Bldg., Chicago, Ill.
Nov. 24, 1913.

[A copy of this letter was shown to Mr. Louer, whose reply is given below. He claims an earlier conception of the general idea, but Mr. Page claims full credit for the design and construction of the plant actually built for the C., M. & St. P. Ry., with the arrangements which permit of its rapid removal and reërection to allow of switching cars in and out of the train.—EDITOR.]

Sir—All I wish to say is that your article describing the car-unloading cableway is correct, and in exact accordance with the facts.

W. B. LOUER CO.
per W. B. Louer.

909 Old Colony Bldg., Chicago.

Free Public Service by Engineers

Sir—In reading your article "Free Public Service by Engineers" in the issue of Oct. 30. I recognize in the illustration used a report made to the Engineers and Architects Club of Louisville, by a committee of which I was Chairman. The matter under consideration being, "Utilization of the Water Power of the Falls of the Ohio."

I heartily agree with you that the engineer is too often called upon by his friends and fellow citizens for gratuitous professional advice. The idea seems to be that so long as he makes no actual measurements, nor prepares plans, there is no occasion for a charge for service. I am inclined to the opinion that this condition of affairs

is largely due to the fact that engineering societies have not made their influence and power more generally felt, but have left to local newspapers or to commercial organizations the discussion of local public matters of an engineerming nature, when the Societies should have taken the initiative and commanded leadership. In the case which you use as an illustration, the Mayor had received and the newspapers published a report from an employer of the Board of Public Works, indorsing a water-power scheme, which, while plausible to the general public was absolutely without merit, and in the Committee's report is passed over as not worthy of serious consideration. At the same time the U. S. Engineer in charge at Louisville had prepared an excellent paper on "Possibilities of Power Development at the Falls of the Ohio," covering a long period of years. If the conclusions arrived at in this paper were correct, it was the duty of the engineers as good citizens, and also to their professional interest, to do all in their power to promote the construction of works which would result in great benefit to the city. The defect in and the only criticism made on this paper by the Committee was that the cost of fuel per horsepower was greatly overestimated and this fact was recognized by the author in a foot note when the paper was published in the Club's Year Book.

The Committee say in the report that: "It is impelled to the conclusion with considerable regret that the development of the power of the Ohio Falls would not be a good financial proposition"; and in presenting the report to the club the writer stated that in the light of improvements in recent years of hydro-electric machinery, the time might come when, with a material advance in the cost of fuel, a combined plant would prove profitable.

Under the circumstances I think that the action of the Engineers and Architects Club was fully as laudable as the action of the Merchants Association of New York, to which you refer, with the difference that the Merchants Association was fortunate in being able to advise favorably as to construction.

In my opinion injustice is being done the engineer in private practice, not by action such as was taken by these clubs; rather is he benefited thereby. Certainly this is the case if the project investigated proves to be a meritorious one.

The greatest injustice to my knowledge, to which engineers are now subjected is the act of the United States Government itself through the Department of Agriculture, office of Public Roads, when under the guise of educating the public it volunteers to furnish any community anywhere in the United States not only plans and specifications but engineering supervision of work, free of charge other than the board and lodging of men so employed.

MARSHALL MORRIS, C. E.

Waukesha, Wis., Nov. 26, 1913.

National or State Control of Natural Resources

Sir—Your editorial of Nov. 27 under the caption, "National or State Control of the Gifts of Nature," deserves some comment. Your article savors more of a political argument than of an engineering or economic discussion. In saying this I am not writing from the standpoint of one who is biased by present surroundings or by future preferment of any kind. I have lived in the West for many years and have spent ten or twelve years in the East. I have attended many of the great conventions where public questions have been discussed and have taken part in some of controversies which have arisen. I feel that your viewpoint is not broad and that your convictions are based on partial information and ignorance of actual conditions in the West. I am not saying that the States should control public resources. Neither do I say that all public resources should be under federal supervision. I do say that up to the present time the States have administered the resources entrusted to their care much more ably than has the Federal government. I now refer to Western States with which I am familiar.

You seem to feel that it was unfortunate that the original States and later the Federal government practically gave away their lands to settlers. It was unfortunate, you say, because title was given the settler without fair return being exacted in the way of a monetary consideration. If you are to argue from the standpoint of the dollar, I must say that you are right. There are to me many other elements of vastly greater importance. These, rather than the money value of resources should invite the interest of engineers. I do not believe we can have a fair discussion of resources of this kind until we admit that the country is composed of people and that lands, minerals, forests and streams are things that should serve these people. We cannot convince the people of New York that it would be better to grow trees on Manhattan Island than to support a city. It may be equally difficult to show a man in Colorado that he should pay special taxes direct to the Federal government, simply because it may be possible for the government to take advantage of him.

In discussing these questions, those who are responsible for such articles as you print in your editorial columns of the last issue of the NEWS, always refer to the necessity of curbing the corporation. Those who have lived in the West and have been compelled to go to Washington in behalf of poor settlers who could not afford to hire lobbyists, know that the corporations are generally well represented at the National Capital. Those who have undertaken this work for the class that needs help understand very well that many of the men who are now so active in the advocacy of Federal control, coöperated in every way with the lobbyists of the great corporations interested in Western enterprises.

I should like to ask you as to how far you believe the user of national resources should reimburse the Federal treasury therefor? Does it appeal to you as just, to place a national tax on power developed from a stream without limiting charges for such power? Even though the charges are not limited, is it right to compel a comparatively small community to pay special taxes to the general government, simply because a river is being used by the local public, when if not used, no one would receive benefit?

As I go about through Eastern States I feel that the resources now in the hands of the people are dedicated to high uses. Where lands can be farmed, it is a mistake to use them for purposes that would possibly not support as high a type of civilization.

You say that "In the far Western States, where the present strong appeal for State control arises, the State Governments are very generally in control of men closely

affiliated with large business interests and they are not in politics or in business for their health." This sentence is on a par with much that I have read along the same line in the literature of publicity agents. I am surprised and grieved to see a great engineering magazine show ignorance and provincialism to this extent. I would like to have some details along this line, if you have facts to support your statement. I have been in close touch with State administrations in the West for 25 years and I am satisfied that the States have shown much more wisdom than has the National government in the administration of resources entrusted to their care. You overlook the fact that we had no administration of streams until the West took the lead and established engineering offices for this important work. How you have failed to follow this important work is difficult for me to understand. Do you know how the Western States administer their public lands? If you did, I am satisfied that you would not be so sure that Federal control is the only panacea for all of the troubles that seem to concern you. I should like to have you study the reform legislation of the past decade. You will find, I believe, that the ideas embraced in this legislation have originated in the West to a large extent and that these laws have been put into operation there first. I need not review these. I am not saying that a good Federal administration might not be devised and made operative. I do say that thus far the Federal government has not shown any great ability in administering public resources. I say, further, that the Western States, which you slander, have shown more ability than have Eastern States or Congress.

Do you think it fair to place the responsibility for poor roads, in a new country such as ours, on the States? The people of the States have been burdened heavily for the construction and maintenance of roads. It is still their problem and there is no reason why many of the public resources should not be made to contribute toward the good-roads movement. When we study these resources from the standpoint of their highest use to the people and forget their intrinsic value to the national treasury or to someone who hopes to build up and support a great bureau at Washington, we will begin to make real progress. A magazine such as yours should entertain no partial sentiments between sections of the country when questions of integrity and honesty are discussed. Let the yellow journal and the politician do this. We can spend our time to better advantage.

CLARENCE T. JOHNSON.

Ann Arbor, Mich., Dec. 1, 1913.

[Our correspondent appears to have largely misunderstood the purport of the editorial note which he criticizes. We said that "Congress may be and often is a very poor custodian of the public interests," and our correspondent says we are "sure that Federal control is the only panacea for all of the troubles." If that is the way a "panacea" is usually commended, then our reading of patent-medicine advertising has been at fault.

We did not say, nor do we believe, that the transfer of public lands to *bona fide* settlers at a nominal consideration, when the whole fertile West was open to settlement, was by any means unfortunate. What we did say was that conditions have changed and public opinion has changed too. Because public land was given away when it was a drug in the market is no reason why at the present day new public lands opened to settlement should be made a prize in a lottery in which the possessor of the fastest horse, or the boldest bluffer is the one who wins. We do not believe such a policy is in the interest of the people, even though a few people may win advantage thereby.

As for "slandering" the Western states, we shall freely admit that the State Governments of many Eastern states would be likewise unsafe guardians of natural resources, held in trust for the public. We wish this were not the case; and we are sanguine that it will not be the case permanently. We are passing through a period of profound and rapid changes. If, as a result of these changes, our State governments can be made strong enough and honest enough to take up and discharge many responsibilities which they have too long neglected, we believe that it will be a reform of the greatest possible public benefit. —ED.]

NOTES AND QUERIES

W. J. H., Newburgh, N. Y., writes: "The prismoidal formula applies to the volume of a sphere by considering the bases (ends of diameter) zero, the altitude 2R and the mid section πR^2. But I do not believe that a sphere is a prismoid. Am I wrong?"

Webster defines a prismoid as "a body whose form approaches the form of a prism." The word "approaches" has a good deal of elasticity. Probably nobody would call a sphere a prismoid from its appearance; but remembering that the prismoidal formula applies to bodies having a curved surface between sections as well as to plane surfaces, the sphere appears to be enough of a prismoid to meet the formula's requirement.

Annual Meeting of the American Society of Mechanical Engineers

The 34th annual meeting of the Society held in New York City last week was one of the largest meetings ever held by the Society. Over 1270 were actually registered in attendance on the convention, including both members and guests, and as a certain number always fail to register it is safe to say that the total number in attendance was over 1300.

The opening session of the Society was held as usual on Tuesday evening, when an address was presented by the retiring president, Dr. W. F. M. Goss, Dean of the Engineering School of the University of Illinois. Prof. Goss took as his subject, "Technical Education a Factor in the Development of Professional Ideals." The address was a broad analysis of the progress of technical education and a discerning forecast of the development which lies before it, and the effect of that development upon the profession as a whole.

Following the address, Mr. James Hartness, the newly elected President of the Society, was escorted to the rostrum and briefly addressed the members. The reception which followed was one of the most largely attended in recent years.

The session of Wednesday morning opened with the annual business meeting at which was presented the reports of the Society's Council and standing committees. The constitution of the Society was amended to provide for a new gradation of the membership. Under the new standards which will govern admission to the Society hereafter, a member of the Society must be at least 32

years of age and have been in active practice of his profession for at least ten years and in responsible charge of important work for five years, and must be qualified to design as well as to direct engineering work. Graduation from an engineering school of recognized standing is considered equivalent to two years of active practice. For the new grade of associate member the requirements are: At least 27 years of age, in active professional practice for at least six years with responsible charge of work for at least one year.

It is of interest to note that the above age requirements are two years greater than the age requirements for admission to the American Society of Civil Engineers. In other respects the requirements exactly correspond to those in the other Society.

Perhaps the most notable feature of the Council's report was the large increase in membership which has taken place during the year, and that increase has been 644, making the total membership on Oct. 1, last, 4986. Besides this, 124 engineers not members of the Society are affiliated with the Society's Gas Power Section, and there are 649 students in the engineering colleges affiliated with the Society's student section.

The finances of the Society are in excellent condition. The receipts for the year were in round numbers $135,000, and the disbursements, $128,000. The Society's total assets are $665,000, and its certificates of indebtedness representing the amount not yet paid for the land on which the Engineering Societies' Building stands are only $68,000, 10% of which is being paid off annually from surplus income.

Perhaps the most notable change in the conduct of the Society's affairs is that the election to membership in the Society is now in the hands of the Council instead of by ballot of the membership at large. As every member of the great national societies knows, balloting on members proposed for admission has become a mere formality, in which a comparatively small percentage of the members take part. It is indeed a relic of the time when the national engineering societies were merely local social clubs, which were carried on in the same manner that had long been customary in such organizations.

A radical change has been arranged for in the issue of the Society's publications. From the beginning of the Society it has been the practice to publish the papers presented at the meetings, first in pamphlet form and later in a bound volume of *Transactions* distributed to all the members. This practice has been continued since the publication of the Society's monthly *Journal* began, so that the papers are really published in duplicate, first in the *Journal,* and afterward with the discussion in the *Transactions.* Such separate publication ends with the present year. Hereafter the members of the Society can preserve their monthly copies of the *Journal* and bind them up at the end of the year as they bind their monthly or weekly issues of other engineering periodicals. The *Journal* will also be altered to the standard 9x12 page, largely used by other engineering periodicals.

The subject which aroused the most brisk discussion at the business session was the report of the Committee on the Standardization of Flanges. This committee, which is composed of Messrs. H. B. Stott, A. T. Ashton, A. R. Baylis, Wm. Schwanhausser, J. P. Sparrow and W. M. McFarland, has done an enormous amount of work in the endeavor to frame a standard for pipe flanges, pipe fittings and bolting, together with a recommendation in regard to the minimum thickness of the wall in cast-iron pipe. This same committee made a report in 1912, which was accepted by the Society and was adopted also by the Association of Master Steam & Hot Water Fitters, a committee of which organization worked in cooperation with the Am. Soc. M. E. Committee in the framing of the standards. The association of pipe manufacturers, however, refused to accept this standard on the ground that the changes required in their patterns to conform to the standards fixed by the committee involved a greater expense than they were willing to undergo. The manufacturers themselves adopted a set of standards, therefore, and refused to fill orders for material conforming to the A. S. M. E. standard except at an increased price.

Under these circumstances the A. S. M. E. Committee held a long series of conferences with the committee representing the manufacturers and as a result a new standard was arranged for, which is in general a compromise between that recommended by the committee originally and that desired by the manufacturers. This new standard, however, has not been accepted by the Association of Master Steam & Hot Water Fitters. The president and the secretary of that Association, therefore, appeared before the A. S. M. E. meeting and opposed acceptance of the committee report, urging that the Society's 1912 standard had already been adopted by various manufacturers who would again have to change should the Society alter its standard originally adopted.

After considerable discussion, a motion was put that action upon the report of the committee be deferred for one year. The motion was carried by a vote of 44 to 36. A vote of thanks was passed to the committee, which has done an enormous amount of work and expended a large sum of money in the preparation of its report. It is hoped that during the coming year agreement can be reached upon a standard between all the various interests concerned, including the New England Waterworks Association and the American Waterworks Association, which are directly interested in the standards for cast-iron pipe.

The professional sessions opened with a paper on the results obtained with the huge boilers at the Detroit Edison Company's plant. These boilers, which are of 2365 rated horsepower, have previously been described before the Society and represent the most notable advance in boiler engineering in recent years. These boilers have shown an overall efficiency for the boiler and furnace varying from about 82% when running at 65% of their rated output to about 77% efficiency when operated at nearly 220% of their rating. So much interest was manifested in the paper on these boilers that discussion of the paper occupied the entire morning session and a part of the afternoon. In fact, as the following paper on "Training for Firemen," by Walter M. Polakov, also related to boiler practice, it may be said that nearly the entire time on Wednesday was devoted to steam boiler engineering. A paper by Prof. R. C. H. Heck, of Lehigh University, on "The Properties of Steam" was presented by title only, subject to written discussion. Reports were also presented by Spencer Miller, for the Society's subcommittee on Hoisting and Conveying Machinery, and a paper on "Dynamic Braking for Coal and Ore Handling Machinery" by Clark T. Henderson.

The Society's sub-committee on Railroads conducted a session Wednesday afternoon at which papers were read on steel freight cars, an abstract of which is given separately. A session was also held on textile engineering, at which papers were presented which had been procured by the Society's sub-committee devoted to this field.

On Wednesday evening occurred one of the important social events of the meeting when the Grashof medal was formally presented to George Westinghouse on behalf of the Verein Deutscher Ingenieure, which awarded the medal to Mr. Westinghouse and made presentation of the same to the A. S. M. E. delegation which met with the Verein in Leipzig last June. Unfortunately, Mr. Westinghouse was unable to be present and the medal was received on his behalf by Mr. James Hartness, President-Elect of the Society.

The large auditorium of the Engineering Societies' Building was filled to its capacity not only to witness this presentation, but to listen to an address, illustrated by lantern slides, on Leonardo da Vinci, by John W. Lieb, Jr., past vice-president of the Society. During Mr. Lieb's long residence in Italy he made an extended study of da Vinci's history, and especially his far-famed work as an engineer, inventor and scientist and the record given by him was of surpassing interest.

On Thursday morning the Society again met in divisions. The Gas Power Section listened to a paper on "A New Process of Cleaning Producer Gas," by H. F. Smith, and a paper on "The Present Status of the Large Gas Engine in Europe," by Prof. P. Langer, formerly of the Technical High School at Aachen. The session was well attended and the papers were actively discussed.

The Committee on Machine Shop Practice conducted a session at which four papers were presented relating to the various features in connection with machine-tool work. Meanwhile, a general session of the Society was held in the Auditorium, at which papers on rope driving, tests of line-shaft bearings, Pitot tubes, tests of vacuum-cleaning systems, vacuum evaporators and enameling steel were presented. These simultaneous sessions enabled the annual meeting to handle a very much greater number of papers than would otherwise be possible, and is indeed a necessity with the increasing specialization in the great field of mechanical engineering.

Some of the older members, however, object that attendance upon a society meeting now partakes of the nature of a "three-ring circus." It is impossible for any one person to attend all the interesting things that are going on at once!

The chief social event of the week was the German dinner held at the Hotel Astor on Thursday evening, at which over 500 were present. The dinner was intended to reproduce as nearly as possible one of the huge banquets at which the delegation of the Society which visited Germany last summer was entertained. Except that the menu card was printed in German and that the Astor ballroom in which the dinner was held was decorated with the American and German colors, the resemblance to a German banquet was not noticeable. The concluding feature of the banquet was an address by Past-President W. R. Warner, illustrated by lantern slides showing some of the principal scenes on the German tour.

The concluding session of the convention, held on Friday morning, was devoted to fire protection, and five papers were presented of special interest to those engaged in insurance engineering and factory organization. Throughout the week, besides the professional sessions the visiting members were entertained by excursions, arranged for by the local committee, to a long list of engineering works in New York and vicinity.

Steel Underframes for Cars and Steel Box-Cars

The afternoon session of the Annual Convention of the American Society of Mechanical Engineers, in New York City, on Dec. 3, in charge of the Sub-Committee on Railroads, was notable for the excellence of the two papers presented and the very light attendance—the latter due to five attractive excursions scheduled for the afternoon and a simultaneous session on "Textiles." The first paper was on "Steel Underframe Box-Cars," by George W. Rink, Mechanical Engineer of the Central R.R. of New Jersey; the second, by R. W. Burnett, General Master Car Builder, of the Canadian Pacific Ry., dealt with the experience of the Canadian Pacific Ry. gained in their operation of 30,000 of the approximately 65,000 steel superstructure cars in service at the present time.

Mr. Rink's paper contained 32 figures and 14 tables which showed the practice on a number of railroads in the United States and Canada.

The discussions on both papers indicated that, although the standardization of certain car parts was imperative, the chances of selecting a standard box-car which will satisfy the particular and divergent needs of all the railroads, are remote. One man favored a car of as light construction as consistent with bare operating requirements, while another insisted that a much higher factor of safety was advisable in order to stand up under the variety of conditions met with in the interchange of cars. This state of affairs is shown in the following extract from Mr. Burnett's paper:

> It may be stated as the writer's opinion that no committee will ever develop a car that will be adopted as standard, but that the nearest we will ever get to a standard is what may be developed by one or two persons given a free hand, and the merit of which is so pronounced that it forces itself upon the country.
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> With the use of structural steel there is less necessity of carrying special parts in stock, on account of repairs being largely a question of labor, and it seems that with this type of car the necessity from a repair standpoint for a standard car is decreasing. This is further borne out by the fact that for the 30,000 cars of this type we have ordered no material for repairs and carry none in stock outside of material common to all cars, except lining; of the lining, our stock amounts to practically nothing. We save out sufficient of the parts from cars destroyed to make up our stock of repair parts, but have found it necessary to use very little of this. There are, of course, many valid reasons why cars should be made to standard inside dimensions and outside clearances.
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> To look at the matter in another way, the wheels, axles, journal bearings, journal boxes, couplers, brakes, safety appliances, etc., which constitute the removable and perishable parts, are all standard and when it is remembered that nearly all of the remaining parts of the cars are standard rolled shapes which are easily obtained, either from the mill or from stock in all principal cities, it is apparent that we now have, in effect, a standard car, or at least a car of standard parts. A car of different dimensions would not increase the cost of maintenance as long as standard shapes are used; nor would it if every lot of cars were designed differently, as long as proper strength is maintained, and any change in design would usually be to increase the strength. In other words, to keep a car as close as posible to standard and reduce cost of maintenance, rolled shapes should be used in preference to pressed shapes where possible.
>
> It is my belief that the people who are urging the adoption of a standard car for maintenance reasons have in mind

the remaining wooden cars, for the maintenance of which large quantities of timbers and castings have to be kept in stock. It is of vital importance that the parts be standardized if that style of construction were to be continued. It should not be overlooked that in a car constructed with rolled shapes these parts seldom need renewal, even when the car is wrecked, as they can easily be straightened or formed to the original shape at any car-repair point, while wood would have to be replaced and pressed shapes would call for special dies to re-form them. With a wooden box-car the amount of material necessary to carry in stock and use for repairs increases rapidly with the age of the car. With a steel-frame box-car the amount of material necessary to carry in stock and use for repairs outside of parts common to all cars does not increase with the life of the car.

STEEL-UNDERFRAME BOX-CARS

During the year 1912, there were built 107,887 box-cars of various capacities and dimensions, all varying vastly in detail design of important parts which require frequent renewal, thus making it necessary for all railway storehouses to carry an unnecessarily large stock of repair parts running into very large sums of money. Standards have been adopted by the Master Car Builders' Association which have in a large measure reduced the amount of stock necessary. I believe the time has arrived to introduce additional standards affecting the maintenance of box-cars which can also be applied to all types of freight cars used in interstate business.

The application of steel underframes to old cars will no doubt prolong their lives. This is now being done by almost every railroad on cars built just prior to the advent of all-steel-underframe box-cars; but care should be taken, to see that sufficient metal is provided to withstand the present service requirements, keeping in view a margin of safety for the future, as no doubt it would be desirable to maintain in sedvice for at least ten years, cars to which these steel center sills are applied.

*

New Specifications for New York State Highway Work

The specifications drafted for New York State highway work by the Advisory Board of Engineers appointed by Commissioner Carlisle, are the subject of attack by the Warner-Quinlan Asphalt Co., of Syracuse, and charges made to Gov. Glynn are now being heard before a special Commissioner, Jas. W. Osborne. The chief item in the charges is that the specifications (which have not yet been made public) discriminated unfairly against certain materials and favored the materials and methods controlled by certain companies.

Meanwhile the New York Department of Efficiency and Economy has sought the advice of Prof. Arthur H. Blanchard, Director of the Highway Engineering Department of Columbia University and his associate, Prevost Hubbard, chemist, late of the Federal Bureau of Road Inquiry, and new specifications have been drafted by these engineers. The following announcement concerning these specifications was given out on Dec. 8:

These specifications have been prepared with a view to standardizing the construction of good roads, and will eliminate the confusion resulting from the use of the different types of construction now recognized by the Highway Department. An important feature of the new specifications is the entire elimination of patented road-construction methods, such as bitulithic, Hassam and Warrenite roads.

All the roads are to be 8 in. thick, and all except one type will have a cement concrete foundation 6 in. deep with a 2-in. top. The object is to make the state roads extremely durable so that the cost of maintenance will be reduced to a minimum.

The proposed specifications submitted by Blanchard and Hubbard contain several radical departures from specifications and customs which have prevailed in highway construction in New York State.

The most important departure is, perhaps, the method of dealing with the asphalt question. Heretofore there have been two general types of specifications recognized. One of these was framed with such narrow technical requirements that it has been construed to represent the product of only one manufacturer. Another type has been so loose in its technical descriptions that nearly every known asphalt has been admitted upon certain kinds of work, with much resultant confusion. The closed, or monopolistic specification, has been the subject of much criticism.

The problem which confronted Messrs. Blanchard and Hubbard under the instructions given them by Commissioner Delaney, was to draft a specification sufficiently general in its requirements to admit every asphalt suitable for road construction, and strict enough in its analytical provisions to compel delivery of only first-grade material. In order to accomplish this, the proposed specifications for asphalt roads contain five separate sets of requirements which are of equivalent value, and instead of one broad formula of analysis contain five separate formulas, each descriptive of several manufactured asphalts. For example, a specification which prescribes the method of construction of bituminous macadam roads, contains a paragraph which states that the bituminous materials to be employed shall measure up to one of five formulas thereinafter presented.

Under this arrangement the product of at least 11 companies now manufacturing asphalt would be admitted on equal terms and a standard established, which probably would increase the number of products admissible, when their manufacturers adapted their plants to the conditions prescribed.

The underlying principle as described by Messrs. Blanchard and Hubbard is that the character of the product is the most important consideration, and that any manufacturer who can furnish material which meets New York State requirements laid down should have his product admitted for road construction.

Messrs. Blanchard and Hubbard declare that to attempt to construct one formula which would admit all of the various kinds of asphalt suitable for road construction would result in such a loosely drawn specification that the Department could exercise no real supervision over the method of manufacture, nor properly inspect or analyze the product when delivered. By constructing a formula for each product admitted in a class, any material presented can be easily identified and a uniform quality can be maintained.

The Highway Department in its specifications for highways outside of cities, now recognizes 16 different types of construction and employs in more or less common use 12 types.

Messrs. Blanchard and Hubbard representing the Department of Efficiency and Economy present in their report only five types of road construction which they approved for highways outside of cities.

No. 1—Waterbound macadam.

No. 2—Bituminous macadam, Type A, of simple construction.

No. 3—Bituminous macadam, Type B, of graded stone.

No. 4—Brick pavement.

No. 5—Stone block pavement.

If the recommendations of the Department of Efficiency and Economy are adopted, all patent roads, such as Warrenite, Hassam pavement, and Amasite, which are included in the specification drawn by the Highway Department Advisory Board (composed of Messrs. Parker, Diehl and Washington), are eliminated. Specification No. 3 is said to be in every way equivalent to the Warrenite pavement and can be constructed at a very much lower cost.

Messrs. Blanchard and Hubbard unqualifiedly condemn what is known as the penetration method and recommend that all stone and asphalt be thoroughly mixed before being placed upon the road. Hot-oil treatment will also be abandoned for construction work if these specifications are adopted.

Every road will be at least 8 in. thick. The waterbound macadam road will have 8 in. of stone and the bituminous-concrete roads will be composed of a cement concrete foundation 6 in. thick and an asphalt concrete wearing course to 2 in. thick.

The brick and stone block roads will also have 6 in. of concrete foundations, with ½-in. sand cushion between the concrete base and the top course. The brick or stone on the surface will be cemented together with an asphalt filler instead of cement; the claim being made that asphalt is more durable on account of its elasticity and is less noisy and much easier to repair.

Another departure from further specifications is a provision for a service test for all materials by requiring that they must have been in use not less than two years before being admissible, and further providing that manufacturers who desire to sell material to the state shall have been engaged in the manufacture of materials for not less than two years; thus demonstrating their ability to produce a high-grade product.

This tentative draft of specifications is to be passed on by a Board composed of Commissioner Carlisle, Attorney-General Carmody and Commissioner Delaney.

A Reinforced-Concrete Water Tank with a Sliding Joint

By L. N. Nishkian* and H. A. Minton†

The last important unit of the high-pressure water-supply system for fire-protection in San Francisco has just been completed and the system is now in full operation. This unit is the Jones St. Tank, a reinforced-concrete structure 60 ft. in diameter, 35 ft. 10 in. in height, with a capacity of 750,000 gal., a sliding joint between the side and bottom of the tank and a conical-shaped roof with no interior support. It is not the intention of this article to describe in detail the fire-protection system, but simply to show the relation of the Jones St. Tank to the system as a whole, and to note the differences between this tank and other reinforced-concrete tanks. A bare outline of the fire-protection system, then, is all that is needed.

Fig. 1. View of Reinforced-Concrete Water Tank for Auxiliary Fire-Service, San Francisco Calif.

San Francisco is a city of hills, the highest of which is a group called "Twin Peaks," or "Los Pechos," as the Spanish picturesquely named it. On the side of Twin Peaks was constructed a reinforced-concrete reservoir with a capacity of 11,000,000 gal. The elevation of the reservoir bottom is 733 ft. Much of San Francisco, particularly the large portion of the business district, is low, at elevations varying from 7 to 60 ft. above mean high water. From Twin Peaks, therefore, the pressure in these low districts would be about 300 lb. per sq.in.—entirely too great for ordinary handling. The original plan considered this, and a part of the scheme was to step the pressure down to a working pressure by constructing two storage tanks in widely separated parts of the city at about 350-ft. elevation.

The first of these tanks was constructed about two years ago, called the Ashbury Heights Tank. This is a steel tank, having a capacity of 500,000 gal. It is located at the base of Twin Peaks at an elevation of 464.5 ft., and serves a double purpose. The Ashbury Heights Tank is filled from the Spring Valley Water Co.'s Tank situated near there at a slightly higher elevation. From the Ashbury Heights Tank the water is pumped by electrically operated pumps to the Twin Peaks Reservoir and in the tank is stored water for fire protection. If Twin Peaks pressure should prove necessary, provision is made for bypassing the water around this tank by a system of valves located in the small pump house adjacent to the tank.

The other tank is the reinforced-concrete tank just completed on the plateau at the top of Russian Hill, at Elev. 334.25 ft., called the Jones St. Tank.

In the remote contingency of the exhaustion of all the fresh water in the pipes in the two tanks and in the large reservoir, salt water will be pumped into the pipes from the two pumping stations located on the Bay. Pumping Station No. 1 is equipped with four steam-turbine pumps each having a capacity of 2700 gal. per min. against a pressure of 350 lb. per sq.in. Pumping Station No. 2 is equipped with two similar pumps having the same capacity.

In case of the failure of either or both stations, a water-supply is insured through the pipe line by means of manifold connections thereto, located along the water front. These manifolds are fitted to receive lines from the fire-boats. Each fireboat can pump 9800 gal. per min. against a pressure of 150 lb. per sq.in.

The pipe lines are safeguarded from possible uselessness due to breaks by the great number of valve controls, so that in a very few minutes a defective line can be shut off from the system by closing a few valves and by bypassing the damaged piece of pipe.

Such, in brief, is San Francisco's auxiliary water-supply system for fire-protection, the last link of which to be constructed was the Jones St. Tank.

The district in which this tank is located is that of the better class of apartment houses, and one of high real-estate value. This is due probably more to the magnificent views of the San Francisco Bay and surrounding hills obtainable than to any other reason. Whatever the reason, the fact that the district was high in realty values and has been extensively rebuilt since the fire with better than average buildings, induced the city engineer to try to make the water tank constructed an ornament to the neighborhood. That consideration was probably chief in determining upon a concrete tank. Another consideration, of course, was the fact that a concrete tank could be built for less money than a steel tank.

In connection with the tank proper was constructed a small reinforced-concrete building for housing the valves controlling the supply to the tank from the Twin Peaks Reservoir and the pumping stations, and the outgo from the tank to the pipe-line system.

The architectural treatment (Fig. 1) of both the tank and the valve house is the same as that used in all municipal engineering buildings in San Francisco, a free handling of the Mission style, which is indigenous to California. Not much chance was offered for a free play to the rein of fancy, owing to the location of the work and the character of the structure. The lot was most irregular, being in fact two lots contiguous to each other for only 30 in. As it was almost impossible to connect the tank with the valve house through this narrow space, a right-of-way was purchased from the owner of a neighboring lot, which permitted the desired connections to be made satisfactorily.

*Assistant Engineer, Board of Public Works, San Francisco, Calif.
†Architect for the City Engineer, San Francisco, Calif.

The tank has a white cement finish applied by the cement gun. The lines of the tank are pleasing, with a simple molded base, an entasis on the side walls, and capped with a rather severe cornice. The severity of the cornice is lightened by a series of luster-tile inserts, twelve in all, one between each pair of triglyphs which mark the corners of the pyramidal roof. The roof is of terra-cotta tile of a reddish color and is crowned with a lantern ventilator, itself roofed with similar tile. As a whole, the appearance of the tank is very pleasing, with the white body and red-tile roof, enlived by the bright colors of the tile inserts in the shadow of the projecting cornice.

The obvious purpose of the sliding joint at the base is to avoid, if possible, the cracks which have usually appeared in the past near the base of the side walls in practically all reinforced-concrete tanks of large size. Fig. 2 shows the joint in detail. The raised rim inside the joint is intended to prevent any great movement in case of earthquake. The circumferential steel angle was used to facilitate construction but it was further utilized for holding in place the lower ends of the 3-in. vertical channels. A 3x⅜x6-in. plate, not shown in the detail, was used under each channel to prevent crushing. The channels were placed about 10 ft. apart and resulted in perfect spacing of the tension bars.

The asphalt under the oakum was in place before the pouring of the side walls, while the rest was poured after completion.

The concrete in the base was first poured and the surface directly under the wall was made as level and smooth as possible with a cement finish. A coating of asphaltic paint was then applied to prevent adhesion to the concrete in the base from the concrete in the walls. The forms for the walls were then built, all the steel placed, and the concrete poured continuously to the construction joint at the top, after which the roof was constructed and poured. After the forms had been removed from the inside of the tank, the joint at the base was thoroughly cleaned out by compressed-air blast. Oakum was then tightly calked into place and the joint thereupon was filled with liquid asphalt.

At the time the tank was filled, unfortunately no observations were made to ascertain to what extent the joint acted. A close examination at the present time shows hair-line cracks every 8 or 10 ft., extending vertically from a point about 2 or 3 ft. from the base, extending to a height of 8 or 10 ft. No horizontal cracks are apparent. This would indicate a partial action of the joints. The cracks probably failed to extend to the bottom on account of the frictional resistance and extended to no greater height on account of the tensile strength of the concrete shell.

The use of the sliding joint at the base has as yet developed no objectionable features. It may be questioned as to whether or not in a tank of this height any movement will take place at the joint. In either case, however, it is believed that the use of a joint is desirable, as it is a very convenient place for a construction joint and eliminates the use of stubs necessary for a rigid connection between base and side walls.

It will be seen in the design of the roof slab that steel was placed in the bottom of the slab to resist bending. Most formulas for conical domes do not consider any bending action because in the development of these formulas the tacit assumption has been made that a rigid ring holds the outer edge of the cone. Under that assumption, the radial and circumferential stresses would be compressive from the apex to the base. Actually, however, in reinforced concrete, no such condition of rigidity exists, and it is obviously absurd to consider the concrete in compression within a few feet of the tension ring at the base. It is evident that if the ring bars are in tension the concrete will crack for some distance from the base, similar to a reinforced-concrete beam, until a region of circumferential compression is reached. Consequently, the roof slab must span from the supporting walls to the compression regions. The necessary formulas for these conditions were developed and the roof designed accordingly.

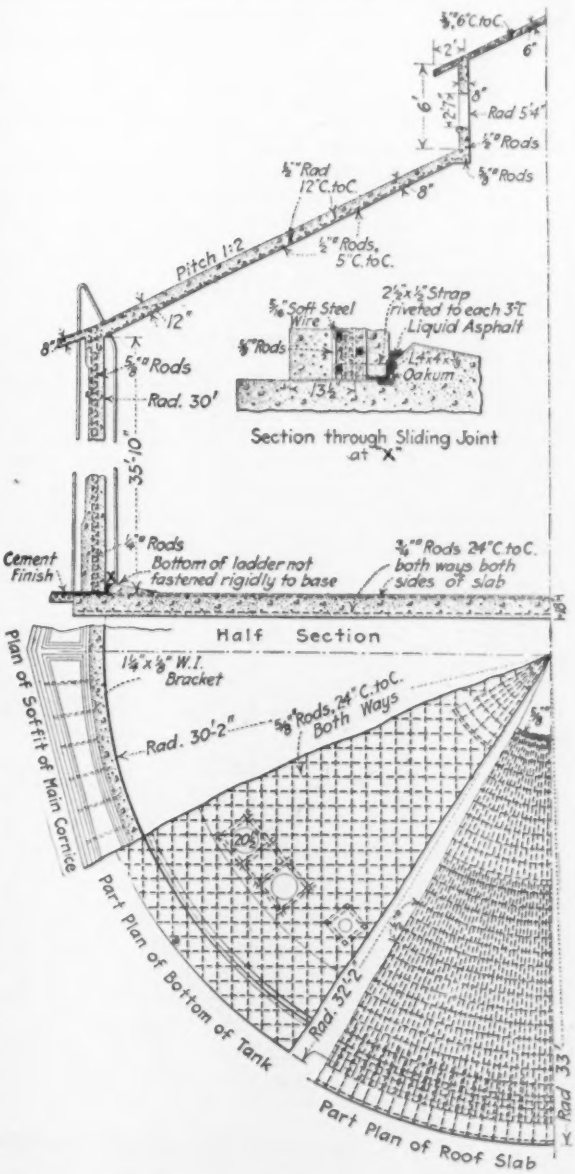


FIG. 2. DETAILS OF REINFORCED-CONCRETE WATER TANK WITH SLIDING BASE JOINT, SAN FRANCISCO, CALIF.

The tension bars in the tank were lapped 36 diameters and were hooked at the ends. All ¾- and ⅞-in. bars were further secured at splices with two Crosby clips, and bars over ⅞ in., with three Crosby clips.

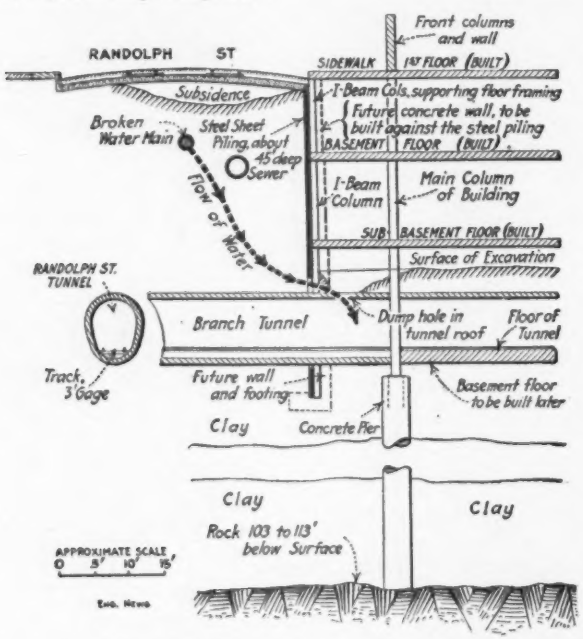
The tank was made water-tight by a ½-in. cement finish in the interior, applied by means of a cement gun. The tank has been full for about three months. At first a few damp spots developed in the lower 20 ft., but no marked leaks are apparent at this time. No cracks other than the hair cracks before mentioned are to be seen on the tank, and it is believed that none will develop hereafter.

The stresses used were as follows: Ring steel in tension, 12,000 lb. per sq.in.; Concrete in cross-bending, compression in roof, 650 lb. per sq.in.

The work was designed and constructed under the direction of M. M. O'Shaughnessy, city engineer of San Francisco. T. W. Ransom was consulting mechanical engineer for the auxiliary water-supply system for fire-protection.

A Street Collapse at Chicago

A stretch of the roadway of Randolph St., Chicago, for about 100 ft. on the block between State St. and Wabash Ave., sank during the night of Dec. 2, to a depth ranging from 2 to 3 ft., so that the street had to be closed to traffic. The location of the break was opposite a new 12-story extension of the Marshall Field dry-goods store, now practically completed.



STREET SUBSIDENCE IN CHICAGO

This building, like most of the large modern buildings in the business section of Chicago, is founded on concrete piers carried down to solid rock, the depth in this case being about 110 ft. to the rock. The disturbance and draining of the clay bed above the rock, due to the excavation, generally results in more or less settlement of the surface so that neighboring shallow foundations, columns of the elevated railway, etc., have to be supported and jacked during the work. The sides of the excavation are supported usually by lines of steel sheet piling, within which are afterwards built concrete walls (generally at the curb line) for the basement. This construction was explained in the article on the Commercial-Continental Bank Building (Chicago), in our issue of Nov. 13, 1913.

At the time of the settlement on Randolph St., the concrete walls of the basement of the Marshall Field building had not been built and the work was not advanced sufficiently for the final work of leveling the streets to proper grade. The basement and sub-basement floors had been built to serve as braces to the wall of steel sheet piling, the floor framing being carried by I-beam columns riveted to the face of this sheet piling. Below the sub-basement, the material was being excavated for a lower basement, whose floor will be level with that of a branch tunnel from the Randolph St. tunnel of the Illinois Tunnel Co., for which branch an opening had to be cut in the steel sheeting, as shown. The removal of the excavated material was being effected by dumping it from wheelbarrows through a large hole in the tunnel roof into the narrow-gage cars standing below.

The ground on both street sides of the building had settled, during the work, and a water main in Randolph St. was broken, probably by the movement of the ground. The escaping water found its way to the opening in the steel sheeting around the tunnel, washing away a mass of material under the street in its course and partly undermining the steel at this point, so that a part of the sidewalk dropped, while water and dirt entered the lower basement. The stability of the building was not affected, since it is founded on rock far below the surface disturbance.

The foundations of the older buildings on the opposite side of the street were not affected, as was shown by levels taken after the accident. The architects of the new building are D. H. Burnham & Co., and the contractors are John Griffiths & Sons.

David Du Bose Gaillard

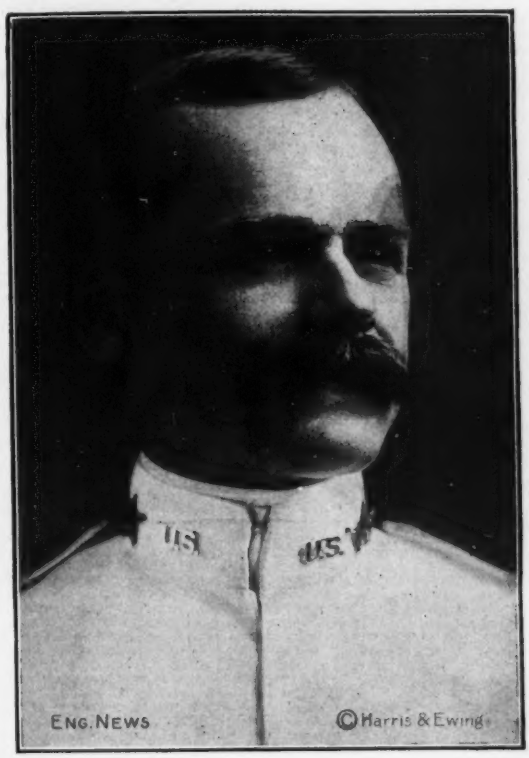
David Du Bose Gaillard, Lieutenant-Colonel, Corps of Engineers, U. S. A., Member of the Isthmian Canal Commission and Division Engineer of the Central (Culebra cut) Division of the Panama Canal, died Dec. 5, at Johns Hopkins Hospital, Baltimore, Md., from a cranial growth upon the brain, believed to be a result of his seven years' arduous work in the tropics. He had been seriously ill since Aug. 17, last, when he was ordered home from the Isthmus, and for the past two months had been in a state of coma.

David D. Gaillard was born in Sumter County, S. C., Sept. 4, 1859. He was educated at private schools until 1874. In 1880, he was appointed a cadet at the United States Military Academy at West Point, and graduated fifth in his class in 1884. He was a classmate of Brig.-Gen. H. M. Chittenden, retired, of Seattle, Wash., Cassius E. Gillette, Consulting Engineer, of Philadelphia, Penn.; and his co-worker on the Panama Canal, Lieut.-Col. Wm. L. Sibert. He was commissioned Second-Lieutenant, Corps of Engineers, June 15, 1884, and attached to battalion of engineers at Willet's Point, N. Y.

After three years' instruction at the Engineer School at Willet's Point, Lieut. Gaillard was made Assistant

to Capt. (now Col.) Wm. M. Black, the engineer officer in charge of river and harbor work in Florida. While in charge of various surveys and harbor improvements at St. Augustine, Tampa and in the Withlacoochee River under Capt. Black, he was promoted to be First-Lieutenant, and in 1891 was made a member of the International Boundary Commission to survey the boundary between the United States and Mexico.

Lieut. Gaillard remained a member of this commission for five years, but his active work in connection with the survey and marking of the boundary ended in 1895, when he was assigned to duty at Fortress Monroe in local charge of defenses. On Oct. 25, 1895, he was commissioned Captain and assigned to duty at Washington, D. C., as Engineer in charge of the Washington Aqueduct and other municipal work. From August to November, 1896, he was engaged in making a survey of the Portland Canal in Alaska.



LIEUT.-COL. DAVID DU B. GAILLARD, LATE DIVISION ENGINEER OF THE CENTRAL DIVISION, PANAMA CANAL
(Copyright, by Harris & Ewing.)

For a short time at the beginning of the Spanish-American War he served on the staff of Maj.-Gen. J. F. Wade, U. S. A., and in June, 1898, was sent to Cuba as Colonel in command of the Third Volunteer Engineers. After a year's field service, during three months of which he was Chief Engineer of the Department of Santa Clara, Cuba, he was reappointed to his previous position in Washington, D. C., as Assistant to the Engineer Commissioner of the District of Columbia.

In 1901, Capt. Gaillard was placed in charge of all river and harbor improvements on Lake Superior, where he remained until June, 1903, when he was assigned to special duty in connection with the General Staff Corps at Vancouver Barracks, Wash. Early in 1904 he returned East, to St. Louis, Mo., as Assistant Chief of Staff of the Northern Division. On Apr. 23, 1904, he was promoted to be Major and in November of that year returned to Washington, D. C., for duty at the Army War College. In March, 1905, he was detailed to duty on the General Staff Corps, and from Oct. 9, 1906, until February, 1907, he was Chief of the Military Information Division, Army of Cuban Pacification, at Marianao, Cuba. He was commissioned Lieutenant-Colonel, Apr. 11, 1909.

Since February, 1907, Lieut.-Col. Gaillard had been a member of the Isthmian Canal Commission and a director of the Panama R.R. Co. For the first year, 1907-1908, he was Supervising Engineer in charge of dredging harbors, building breakwaters and other preliminary operations. On July 1, 1908, he was appointed Division Engineer of the Central Division, extending from Gatun to Pedro Miguel. By his brethren of the engineering profession, at least, it can be easily appreciated that this was a most difficult and arduous piece of work, requiring courage, resourcefulness, untiring energy and constant good humor in face of the pessimistic predictions of the daily press and, in many instances, of engineers.

It is greatly to be regretted that a man who contributed so much to the success of this great enterprise, for which he truly gave his life, should not have lived to witness its completion, or least to have died with the knowledge that every detail gave proof of ultimate success But even this was denied him, for during the last few months, in which the locks have been completed, the steam shovels removed from Culebra cut, the Gamboa dike destroyed and the water admitted to the cut, dredges set to work, and vessels actually passed from end to end of the great waterway, Col. Gaillard has been lying unconscious in the hospital at Baltimore.

This is particularly the case because of all those occupying positions of high responsibility in connection with the great work at Panama, Gaillard will by common consent be awarded chief place for enthusiastic interest in the work. Many, if not most engineers, as they advance in years become so accustomed to the routine of professional work that they follow it from force of habit and lose the interest in it that animated them in the years when life was new. But Col. Gaillard was a man who possessed in rare degree the quality of youthful enthusiasm, a quality that made him most attractive as a friend and as a co-worker.

From one point of view, his task was one of the least spectacular on the Isthmus, even though in point of dollars spent and material moved it was the hugest of all. The great feat that he accomplished in this task was not the battling with slides or the design of the plant and equipment. It is expressed in the statement that this huge piece of excavation, the largest ever undertaken in the world, beset by many great difficulties, all tending to make the work unduly expensive, has been carried out at a cost per cubic yard removed which has seldom been even approached in work carried on anywhere in the world under the most favorable conditions.

The great number of engineers who have visited Panama during the past five years and have met Col. Gaillard there, with the host of friends who have known him elsewhere, will join heartily in Col. Goethal's simple but eloquent tribute:

"Col. Gaillard was a great engineer, an unflinching worker and a true gentleman."

Col. Gaillard was married at Winnsboro, S. C., Oct. 6, 1887, to Miss Katherine Ross Davis, of Columbia, S. C., who, with one son, Lieut. David P. Gaillard, U. S. A., survives him.

NOTES

The Valuation Engineers' Gradings published in our issues of Nov. 13 and Dec. 4 should have been classified into the following grades: 70 to 80%, 81 to 90%, 91 to 100%. We have been informed that some of those taking the examination have had grades of precisely 80% or 90%, and they were anxious to know into which class they had fallen.

Deaths on Grade Crossings in New York State numbered 13 during November, while 12 persons were injured, according to E. S. Clewes, of the National Highways Protective Society. In New Jersey, the figures were: Five killed and four injured. Of the 18 killed in the two states, 11 were pedestrians who were not trespassing (merely passing over the tracks at grade crossings), five of the remaining seven were in automobiles, and two were in wagons.

Systematic Stream-Gaging by State Authorities is the subject of present agitation in Ohio which is expected to be carried to successful issue at the next legislative session. The investigation made subsequent to the disastrous floods in Ohio last March, brought out very strikingly the inadequacy of stream-gaging records now available. That the collection of information and records in matters concerning streams is an essential duty of the state, which has the care of these streams, is the view which lies at the bottom of the proposal to establish stream-gaging. At present only three or four states are conducting regular stream-gaging work.

A Wooden Derrick-Boom Broke in Half, while raising a load of six tons of steel columns from the street to the sixth floor of a building now under construction at Broadway and 37th St., New York City, on Nov. 29. The derrick was installed on the sixth floor, and the boom had lifted the load 4 ft. above the ground when the topping lift snapped, dropping the load to the street, and the boom upon the steelwork of the sixth floor. The boom (which was 70 ft. long by 14 in. in diameter) snapped at the point where it struck, the overhang falling to the street. Ravitch Bros., of New York City, who are handling the structural steel contract, state that this same derrick hoisted loads of from 20 to 30 tons each about ten days ago on this same job.

The Indictment, Which Followed the Austin (Penn.) Dam Failure, of manslaughter in the second degree, against George C. Bayless, of Binghamton, N. Y., President of the Bayless Pulp & Paper Co., of Austin, was dismissed by Judge Cameron, at Wellsboro, N. Y., on Nov. 25. Claims totaling $500,000 had been filed against the company and the civil lawsuits to collect this amount were recently dropped on the payment of $150,000. The Bayless Mill Dam failed on Sept. 30, 1911; 80 lives were lost and the villages of Austin and Costello, Penn., were flooded. The failure of the concrete dam at Austin, Penn., was described and discussed in "Eng. News," Oct. 5, 1911, pp. 410, 417-422.

A Water Shortage in Cincinnati, Ohio, was caused by the breaking of a large water main on Dec. 6. Many factories were forced to shut down; press reports estimate the number of men thus thrown out of employment at 60,000. The Ohio Electric Ry. Co. maintained a partial service by hauling water from the Ohio River to its generating stations. During the trouble the city will be adequately supplied by a high-pressure water system. To meet emergencies in the event of fire, 10 automobile chemical engines were collected in the business district.

A New York Subway Crash occurred, at 10:20 a.m., on Dec. 4, when the last car of a train from South Ferry sideswiped the first car of an incoming train from Brooklyn, knocking off a forward truck of the Brooklyn train, just south of the Bowling Green station. No one was injured but traffic was delayed more than an hour. Frank Hedley, General Manager of the Interborough Rapid Transit Co., made the following statement regarding the accident:

The train from South Ferry was coming around the Bowling Green loop and had the right-of-way. The signals and switches were right. The motorman of the train from Brooklyn says the distance signal was at caution, and that the home signal turned red just as he appeared in sight of it, and he could not stop before bumping into the other train.

A City Planning Exhibition was opened at the New York Public Library, New York City, on Nov. 24, and gave rise to so much interest that instead of closing it on Dec. 7, the time was extended to Dec. 14. The exhibit was financed jointly by the city of New York and the Merchants' Association of New York City, and was collected and installed by the American City Bureau, 93 Nassau St., New York City, directed by an advisory commission of which Geo. B. Ford was secretary. Besides more or less comprehensive schemes for improving the plans of specific cities, there were shown many photographs of public buildings. There were also hundreds of plans, photographs, etc., grouped under such heads as parks, monuments, housing, garden cities, markets, factories, water-supply and sanitation, streets, waterways, docks and harbors. Included in the list of cities represented in the collection of city plans were New York, Chicago, Baltimore, Cincinnati, Newark, Jersey City, Pittsburgh, Seattle, Salem, Mass., and Columbia, S. C. Conjointly with the city planning exhibit was one provided by the Heights of Building Committee of New York City. This exhibit contained a large number of special maps showing in detail the classes and heights of buildings in New York.

An Engineer on the Interstate Commerce Commission is requested by the American Institute of Consulting Engineers in a recent letter to President Wilson. The letter calls attention in the following words to those duties of the Commission to which one with an engineering training is especially adapted:

The leading part taken by the engineer in surveys, location, construction and operation of the railroads, gives him special training, skill and acquaintance with their details which would be of the greatest value in the study and decision of the cases that come before the Commission and particularly in the executive work of Physical Valuation.

We submit that while several years are required for a lawyer, politician or other layman to become familiar with the technical details of rail transportation, the engineer, on the other hand, is already acquainted with them. He can examine the details and special facts presented for adjudication without loss of time or unnecessary expense to the public through lack of preparation. With one or more engineers as members of the Interstate Commerce Commission we believe that the duties and responsibilities of the other Commissioners would be greatly lightened.

While the regulation of rates is not wholly an engineering question, the knowledge of the experienced railroad engineer would be helpful and valuable in its consideration. The economic and commercial factors underlying the rate structure are more familiar to him than to any other except the traffic expert.

Safety appliances and the investigation of accidents on the railways are matters wholly technical and an engineer commissioner would therefore render inestimable service in reviewing the reports of inspectors and giving them proper value. The decisions and recommendations upon the subject of safety appliances, such as block signals and steel equipment, promulgated by the Interstate Commerce Commission, would be authoritative and command the respect and confidence of the general public and of the carriers if participated in by well known engineers.

The physical valuation of railways is perhaps the most important engineering work now being done in this country. Its cost will be great, it has little useful precedent, and the whole responsibility for the task rests with the Commission. While the Commission will be aided, of course, by engineering boards and experts, the work will be dominated and directed by the Commission.

While urging the appointment of an engineer on the Interstate Commerce Commission, we do not maintain that technical knowledge constitutes by itself a sufficient qualification; a judicial temperament, executive ability and tact are as necessary for a useful engineer member of the Commission as for any other; if, therefore, you decide to appoint an engineer, we ask that you select one having these essential qualifications as well as the highest professional attainments.

An engineer of the type we ask you to consider will not serve in a subordinate capacity under laymen, but would probably make personal sacrifice for the honor of serving under your administration as a member of the Commission and with the thought of performing a duty as a citizen.

PERSONALS

Mr. J. S. Moore has been appointed Assistant Superintendent of the Virginian Ry., with office at Victoria, Va.

Mr. William J. Calvin has been appointed Roadmaster of the Northern Pacific Ry. at Ledro-Woolley, Wash., succeeding Mr. William H. Gale, resigned.

Mr. C. A. Wright, Superintendent of Terminals at East St. Louis, Ill., of the Chicago & Alton R.R., has resigned, and the position has been abolished.

Mr. C. B. Adams has resigned as Chief Inspector of the Pressed Steel Car Co. Pittsburgh, Penn., to accept a position with the Western Steel Car Co., Chicago, Ill.

Mr. W. R. Roy, a building contractor of Spokane, Wash., has been appointed State Highway Commissioner of Washington, succeeding Mr. W. J. Roberts, M. Am. Soc. C. E., resigned.

Mr. W. R. Phillips, recently Designing and Sales Engineer of the Columbia Concrete Steel Co., Pittsburgh, Penn., is now Contracting Engineer of the Samuel Austin & Son Co., Cleveland, Ohio.

Mr. Theodore A. Bergen, Assoc. Am. Inst. E. E., Electrical Engineer for Lockwood, Green & Co., Chicago, Ill., has resigned to become Chief Engineer of the Sveriges Industri-Förbund, of Stockholm, Sweden.

Mr. Charles W. Brown, recently Engineer of Maintenance-of-way of the Lehigh & New England R.R., at South Bethlehem, Penn., has been appointed Assistant Superintendent with headquarters at South Bethlehem.

Mr. Robert F. Byers, formerly Shop Foreman of the National Rys. of Mexico, at Aguacallentes, Mex., has been appointed Master Mechanic of the Central Dominicano Ry., with headquarters at Porto Plata, Dominican Republic.

Mr. W. A. Kelly, Drainage Engineer, U. S. Department of Agriculture, Office of Experiment Stations, has been transferred from Billings, Mont., to North Yakima, Wash., succeeding Mr. W. W. Weir, transferred to Berkeley, Calif.

Mr. John A. Drew, for many years New York Sales Manager for Henry R. Worthington and the International Steam Pump Co., is now Special Sales Agent for the Epping-Carpenter Pump Co., with offices at 90 West St., New York City.

Mr. Edward C. Sherman, M. Am. Soc. C. E., Consulting Engineer, Boston Mass. has been made Editor of the new "Journal" of the Boston Society of Civil Engineers which has withdrawn from the Association of Enginering Societies and will publish its own proceedings.

Mr. F. W. Gilcreast, Chief Engineer of the Lehigh & New England R.R., at Mauch Chunk, Penn., has been appointed Engineer of Maintenance-of-way with office at South Bethlehem, Penn., succeeding Mr. Charles W. Brown, promoted as noted elsewhere. The office of Chief Engineer has been abolished.

Mr. W. Randolph Sides, formerly a member of the engineering staff of the Board of Water Supply, City of New York, and later with the Bureau of Highways, Borough of Brooklyn, has been appointed Assistant to the Manager of the contracting department of the Turner Construction Co., New York City.

Mr. Judson G. Dickerson, Chief of the Gas Testing Department of the City of Chicago, Ill., has been appointed Chief of the Bureau of Gas of the City of Philadelphia, Penn., at a salary of $5000 per annum, succeeding Dr. Hollis Godfrey, M. Am. Soc. M. E., who has been elected President of Drexel Institute, as noted elsewhere.

Mr. H. M. Flanders, Roadmaster of the Springfield (Mass.) Street Ry., has been appointed Engineer of Maintenance-of-way of the Springfield Street Ry., the Worcester Consolidated Street Ry., the Milford, Attleboro & Woonsocket Ry., and the Attleboro Branch R.R. Mr. Flanders was educated at Massachusetts Institute of Technology.

Mr. T. N. Jacob, M. Am. Soc. C. E., whose resignation as Chief Engineer of the East Side Levee and Sanitary District, East St. Louis, Ill., was noted in our issue of Nov. 13, has opened offices at 300 Cahokia Bldg., East St. Louis, for private practice, specializing in levee and drainage projects, railways, mines and municipal engineering.

Col. S. D. Lehr, for more than 20 years City Engineer of Allentown, Penn., has been elected one of the five commissioners of the city under the new commission-plan government, recently authorized by the Pennsylvania legislature. Col. Lehr is a Civil War veteran, a former Mayor and for years City Engineer of Allentown. He will be Director of Public Works.

Dr. Hollis Godfrey, M. Am. Soc. M. E., recently Chief of the Bureau of Gas, Philadelphia, Penn., and formerly Consulting Engineer and head of the department of science, School of Practical Arts, Boston, Mass., has been elected President of Drexel Institute, Philadelphia. Dr. Godfrey is a graduate of Tufts College and of the Massachusetts Institute of Technology, class of 1898.

Mr. George F. Swain, President, Am. Soc. C. E., has resigned as Consulting Engineer on bridges for the Massachusetts Public Service Commission, a position which he has held (for the old Railroad Commission) since the Bussey bridge accident in 1887. In the reorganization of the Railroad Commission it was desired to have an engineer who could give his whole time to the office, which Prof. Swain's many duties will not permit him to do.

Mr. Winslow H. Herschel, M. Am. Soc. M. E., formerly Associate Professor of mechanical engineering at the University of Maine, and recently Inspector for the Isthmian Canal Commission, Pittsburgh, Penn., has been appointed Assistant Physicist, U. S. Bureau of Standards, Washington, D. C. Mr. Herschel is the son of Mr. Clemens Herschel, M. Am. Soc. C. E., Consulting Engineer, New York City, and is a graduate of Harvard University.

Mr. E. C. Hurd has resigned as Chief Engineer of the Valuation Department of the Nebraska State Railway Commission to enter private practice as a consulting engineer with offices at Chicago, Ill., and Lincoln, Neb. He will continue a part of his work for the Nebraska Commission in a consulting capacity. The work of the Physical Valuation Department of the Nebraska Railway Commission was described in our issue of Aug. 15, 1912.

Mr. G. C. Cleaver, recently Division Engineer of the Buffalo, Rochester & Pittsburgh Ry., at Du Bois, Penn., has been promoted to be Engineer of Maintenance-of-way, with headquarters at Rochester, N. Y. Mr. Cleaver is succeeded at Du Bois by Mr. E. W. Hammond, who becomes Division Engineer of Divisions 3, 4 and 5. Mr. J. P. Reynolds has been promoted to be Division Engineer of Divisions 1, 2 and the Erie Division, at Rochester, succeeding Mr. Hammond.

Mr. W. C. Hattan, Assoc. M. Am. Soc. C. E., former Resident Engineer at Millard, Va., has been appointed Division Engineer of the Elkhorn division of the Carolina, Clinchfield & Ohio Ry., at Dante, Va. Mr. Hattan is a graduate in civil engineering of Washington and Lee University, class of 1899, and has been in railway construction work in the South since the summer of 1899. In 1904-'05 he was Resident Engineer on the Cumberland extension of the Western Maryland Ry.

Mr. Walter G. Kirkpatrick, M. Am. Soc. C. E., City Engineer of Birmingham, Ala., has resigned, effective Jan. 1. The city has decided to economize by cutting the expenses of the city engineering department $6500 a year. After the first of the year Assistant City Engineer, Mr. Maury Nicholson, M. Am. Soc. C. E., will be acting head of the department. The city commissioners have cut the annual budget $83,000 for the coming year, 75% of which is stated by the Birmingham "Age-Herald" to be in salaries of city officials.

Mr. Laurence B. Finn, President of the National Association of Railway Commissioners, has named the following members of the various state railway and public utility commissions as a Committee of Fifteen to coöperate with the Interstate Commerce Commission in making a physical valuation of railways: Messrs. Fred J. MacLeod, Boston, Mass.; E. C. Niles, Concord, N. H.; Milo R. Maltbie, Albany, N. Y.; R. Hudson Burr, Tallahassee, Fla.; Chas. M. Candler, Atlanta, Ga.; Edward W. Doty, Columbus, Ohio; Orville F. Berry, Springfield, Ill.; Lawton T. Hemens, Lansing, Mich.; Halford Erickson, Madison, Wis.; H. S. Martin, Topeka, Kan.; J. M. Atkinson, Jefferson City, Mo.; Geo. A. Henshaw, Oklahoma City, Okla.; John M. Eshleman, San Francisco, Calif.; H F. Bartine, Carson City, Nev.; Clyde B. Aitchison, Salem, Ore.

Mr. Fairfax Harrison, formerly President of the Chicago, Indianapolis & Louisville Ry., has been elected President of the Southern Ry., and its subsidiary lines, succeeding the late W. W. Finley. Mr. Harrison's career has been quite different from those of most of the presidents of large railway systems; instead of reaching his present office through the engineering, operating or traffic department, he has come through the legal, financial and accounting departments. Mr. Harrison was born in New York City, Mar. 13, 1869, and graduated from Yale University in 1890. He was admitted to the bar in New York City in 1892 and practiced law until 1896, when he was appointed Solicitor for the Southern Ry. and later Assistant to the President. He was made Vice-President in charge of the financial and accounting departments in 1906, and resigned in 1910 to become President of the Chicago, Indianapolis & Louisville Ry.

OBITUARY

Jerome S. Gingrich, Assistant Superintendent of the Labanon Valley Electric Ry., was killed Dec. 2, by being caught between two cars in making a coupling on the inside of a curve, an accident against which he had issued many warnings to his employees. He was 46 years old.

David E. Haire, a consulting refrigerating engineer, died at his home in Philadelphia, Penn., Dec. 4. For a number of years he was Chief Engineer of the American Ice Co. His early experience in engineering was gained in the steel mills of Ohio, Pennsylvania and West Virginia. He was a member of the Society of Refrigerating Engineers and of the Manufacturers Club of Philadelphia. Mr. Haire was 51 years old and leaves a widow, two daughters and two sons.

Maurice Byson Patch, M. Am. Inst. M. E., Superintendent of the Buffalo Smelting Works, Buffalo, N. Y., died Dec. 3, from acute indigestion. He was born in Massachusetts in 1852 and graduated from the Massachusetts Institute of Technology in 1872. He had been connected with the Great Lakes copper mining industry ever since the completion of his college course and was a recognized authority on copper smelting. For many years he had been connected with the Calumet & Hecla Mining Co., and for more than 20 years had been Superintendent of its Buffalo Smelting Works. Mr. Patch was a member of the Grade Crossing Commission of Buffalo, and since 1912 its Chairman. He is survived by three sons and two daughters.

ENGINEERING SOCIETIES

COMING MEETINGS

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.

Dec. 29-31. Seventh annual convention at Chicago, Ill. Secy., I. W. Dickerson, Urbana, Ill.

AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE.

Dec. 29-Jan. 3. Sixty-fifth annual meeting, at Atlanta, Ga. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.

Jan. 5-7. Fifth annual convention at Washington, D. C. Secy., T. R. Maul, 409 P. O. Building, Philadelphia, Penn.

MINING AND METALLURGICAL SOCIETY OF AMERICA.

Jan. 13. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION.

Jan. 20-22. Tenth annual convention at New Orleans, La. Secy., F. J. Angier, Timber Preservation Co., Baltimore, Md.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Jan. 21-23. Annual meeting in New York. Secy., E. A. Scott, 29 W. 39th St., New York City.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.

Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

Engineers' Club of St. Louis—The annual meeting will be held at the Club, on Dec. 3. The Secretary is W. W. Horner, 3817 Olive St., St. Louis, Mo.

Mexico Section of the American Society of Electrical Engineers—The regular monthly meeting of the Section was held in Mexico City, Mexico, on Nov. 28, and was preceded by a dinner. Engineers will be interested to note that affairs in Mexico have not yet interfered with the regularity of technical meetings.

The New Jersey Sanitary Association—The 38th annual meeting of the Association was held at Lakewood, N. J., Dec. 5 and 6. In the course of an address on "Adequate and Consistent Means for the Protection of Public Water-Supplies," Prof. H. N. Ogden, of Cornell University, urged that more use be made of existing law against water pollution than is now done; that more use be made of the sanitary patrol of drainage areas and that greater efforts be made to secure the proper operation of water-purification plants. State control of such plants was advocated, the state authority having jurisdiction to step in and operate the works when weekly reports show the local operation to be inefficient. A recent instance was cited of the appointment of a wire lineman as assistant chemist to a water-purification plant with the understanding that after two months' training by the chemist the latter would be replaced by the assistant.

J. Brognard Betts, of Plainfield, was elected President of the Association for 1913-14; Geo. W. Fuller, of Summit, was elected Chairman of the Executive Committee; Dr. Edward Guion, of Atlantic City, was reëlected secretary and Geo. P. Olcott, of East Orange, was reëlected treasurer.

American Institute of Consulting Engineers—Important subjects were considered at the meeting of Dec. 2 at the Engineers' Club, New York City.

A proposal that the Institute join the "International Union of Consulting and Expert Engineers" was discussed, but no final action was taken; the divergence of conditions and aims here and in Europe, it was held, tends to make such affiliation inadvisable.

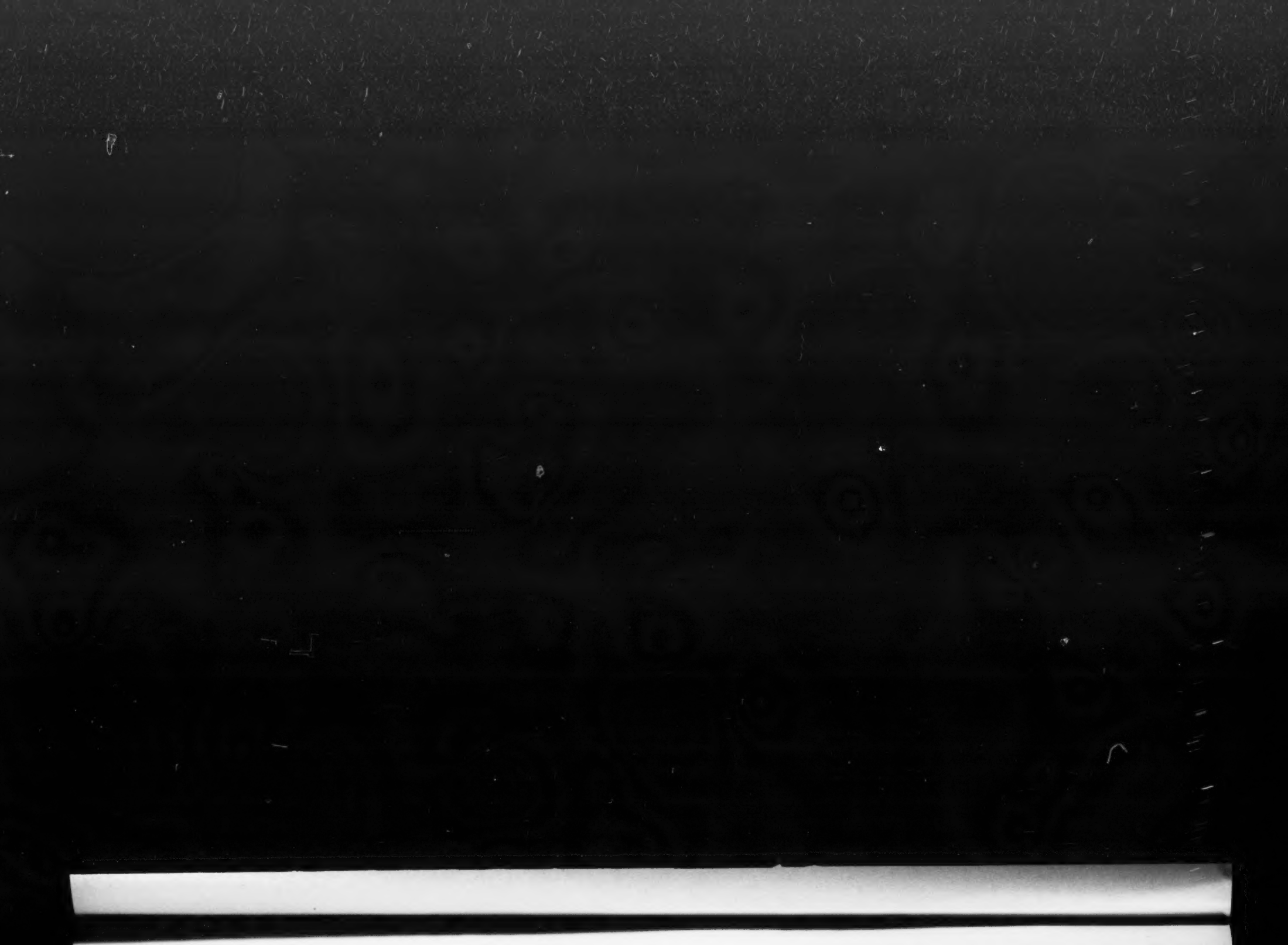
Proper and improper soliciting of engagements by consulting engineers was talked over at considerable length. Many speakers took the position that modern business conditions, especially in the mechanical and electrical fields, make it impossible to adhere to the conservative practice of waiting for clients. It was conceded to be a question for the individual how far he may go in making publicity, in going out after business, etc. Various cases from personal experience were cited in support of both sides. Proper emphasis was also given to the fact that a large element of the consulting engineer's business comes from other engineers, and it was declared to be desirable that this element should be increased, particularly through working for such conditions that municipal engineers, especially those in small towns, will be able to secure the retention of consulting engineers for special problems. A good word was also said for working under a contingent fee, which while contrary to the established principles of correct practice is sometimes a useful and necessary evil. At its close the discussion focused on the fact that the public at large does not appreciate the functions, capabilities and services of consulting engineers sufficiently, and it was voted to appoint a committee of five to consider whether and how the public should be advised on this subject.

A proposal having been made some time ago that the requirements of admission of the Institute be modified, to enlarge the membership, the matter was discussed at length. One point at issue was the admission of professors of engineering; another was the admission of engineers primarily in salaried service, but doing also consulting work. The question of whether engineers to contractors or engineers affiliated with contracting firms should be admitted also came up inasmuch as several members of the society at the present time are so affiliated (though independent consulting engineers at the time of admission into the Institute). The general opinion favored sticking strictly to the original principle that only independent consulting engineers be admitted, and this was in the discussion interpreted to mean that a professor of engineering is eligible only if he is also a noted consulting engineer and can claim admission on his consulting work alone. Several argued very strongly against the admission of professors as such. The matter of the minimum age of admission was also injected into the discussion, and several advocated that the age limit be raised from 35 to 40 years. The moving element of the discussion was the conclusion, on the part of the governing body of the Institute, that for fullest efficiency its membership should be enlarged both in numbers and in geographical extent. It was pointed out by Chairman Alfred Noble that the Institute at present has no membership in such centers as Cincinnati, New Orleans and San Francisco. No direct action resulted from this discussion.

In further discussion of some additional matters on which the society may take action in the near future, very strong views were expressed as to the need of the engineering profession purifying itself of members who transgress proper principles.

It was reported by Secretary E. W. Stern that the Institute has a committee in conference with the American Institute of Architects for action in opposing the practice of contractors preparing plans for work on which they and their competitors afterward submit bids. The initiative in this matter came from the architects and represents the recognition of an evil of long standing and considerable extent.

The Institute has addressed President Wilson on the matter of appointing engineers to the Interstate Commerce Commission. It has also appealed to Mayor-elect Mitchel, of New York City, urging that certain departments of the city government be headed by engineers; and to the borough presidents urging that certain bureaus under their charge be headed by engineers, particularly the Bureau of Buildings and the Bureau of Public Works.

The preparation of a draft of a license law is being carried on by the five leading engineering societies and the American Institute of Consulting Engineers through a conference committee. The situation in this matter is that none of the societies themselves favor the passage of a license law, but realizing from the experience of the past few years that there is a certain amount of political sentiment in favor of such a bill it is feared that an improper bill may be passed unless the societies themselves prepare one with due attention to all necessary features. It has not yet been decided whether the completed bill is to be presented to begin with or whether it is to be held in abeyance and only presented to the legislative committee when the subject of a license law is raised by other parties.

The Institute has been incorporated, by the indirect method of forming the American Institute of Consulting Engineers, Inc., and having the members of the original organization transfer individually to the new one. The finances of the Institute are good, a net balance of $2500 being reported.